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Art and Mystery of the Foundryman

Using the above caption, Sir Alfred Herbert, the eminent engineer, has given an excellent discourse on the foundry industry. However, it suffers, as do most statements from prominent people, from an insufficient appreciation of just what the foundry industry is. If Sir Alfred's statement (reproduced elsewhere in this issue) is analysed, it will be apparent that he has iron castings for the machine tool trade uppermost in his mind, and his opening phrase discloses this, wherein he states, "munitions of war make little demand on the ironfoundry." Yet a simple subtraction sum reading "total peacetime production of castings, minus builders', civil engineering and textile castings, equals the quantity necessary to wage a total war." Put into round figures this would mean 3.5 million minus a million tons equals 2½ million tons. Munitions to-day has a wider implication than just armaments.

Sir Alfred correctly ascribes the existing shortage of castings to the dearth of foundry labour. He has the courage to stress the incidence of snobbery as a psychological factor acting adversely against recruitment. Incidentally, this factor is well known and much utilised by the publicity experts, who, when selling anything ranging from cigarettes to face cream, will aver that "plugging the snob complex has never been known to fail." Could not those responsible for the forthcoming recruiting drive for foundry labour also, by some imaginative twist, make use of this "complex." "Become a Prince of Craftsmen" might make a better appeal than the conventional material now being prepared.

It was pleasing to note that Sir Alfred insists that machine tool structures are best made weighty to ensure rigidity and minimise vibration. Good reasons are given for the employment of foreign labour. To our mind, the position of the foundry industry can best be summed up by examining world conditions. America has an enormous backlog of orders due to war conditions. Europe suffers similarly, but in addition there are the rehabilitation of destroyed cities and industries, and manufacturing stagnation in large areas which before the war made a serious contribution to the castings requirements of the world. The attraction of much foundry labour to this country would enable the engineering concerns to get busy making the machinery once turned out by these derelict areas.

It was also pleasing to hear from such an eminent engineer the requisite attributes for the higher executives of the foundry industry. Sir Alfred will, no doubt, share our view that the engineer-director has in the past been far too parsimonious in the supply of modern equipment for the foundries under his control. The machine shop superintendent could without difficulty persuade him to purchase a £4,000 machine tool, whilst the foundry manager would be refused a machine costing £400. Nor has this mental kink quite been dissipated, as only recently we heard of a customer furnishing a foundry concern with moulding machines wherewith to give increased production of urgently needed castings.

Enlightened foundrymen will associate themselves with us in expressing our appreciation of statements of the type made by Sir Alfred. Their grumble for years has been the lack of interest by industrialists in general in castings. Too often they were regarded—and still are by some of their buyers—as a commonplace commodity to be bought in the cheapest market. In the present state of this country, the most important factor for its future is "seed money," and, to mix our metaphors, this must be "ploughed" into the foundry industry in order to gear up trade in general so that it can substitute the inane slogan "Britain Can Make It" into "Britain Is Delivering the Goods."

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FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

JANUARY 3.

Institution of Chemical Engineers (North-west branch):—Annual general meeting. "Aspects of Pilot Plant Development," by C. E. Rowe. At the College of Technology, Manchester, at 3 p.m.

Institution of Mechanical Engineers:—"Developments of Aircraft Hydraulic Machinery," by H. G. Conway, S. M. Parker, and D. A. L. Robson. At the Institution, Storey's Gate, London, S.W.1, at 5.30 p.m.

JANUARY 7.

Institution of Chemical Engineers:—"Chemical Engineering Aspects of the Fischer Tropsch Process," by Dr. C. C. Hall and A. H. Taylor. At the Geological Society, Burlington House, Piccadilly, London, W.1, at 5.30 p.m.

JANUARY 9.

Institute of Metals:—"Lead," by A. Makower. At the Institute, 4, Grosvenor Gardens, London, S.W.1, at 7 p.m.

JANUARY 10.

Keighley Association of Engineers:—"Textile Machinery." At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

JANUARY 11.

Keighley Association of Engineers:—Visit to John Lund, Limited, at 2.30 p.m.

Institute of British Foundrymen

JANUARY 7.

Slough section:—"Melting Furnaces." At the Lecture Theatre, High Duty Alloys, Limited, Trading Estate, Slough, at 7 p.m.

JANUARY 9.

East Anglian section:—"Short Visit to the U.S.A.," by F. Tibbenham. At the Lecture Hall, Central Library, Ipswich, at 7 p.m.

Lancashire branch:—"Apprenticeship Training," by J. Gardner. At the College of Technology, Sackville Street, Manchester, at 7 p.m.

JANUARY 11.

Birmingham branch:—Annual dinner and dance. At the Botanical Gardens, Edgbaston, Birmingham.

West Riding of Yorkshire branch:—"Problems of the Jobbing Foundry," by A. E. McRae-Smith. At the Technical College, Bradford, at 6.30 p.m.

FLUIDITY OF MOLTEN STEEL

Mr. C. H. Kain writes that the remarks attributed to him on page 404 of our December 19 issue appear to have been incorrectly reported. A correction of the major inaccuracies is given as follows.

In the answer to Mr. Jackson, the Authors stated that well-made converter steel had definite characteristics and was therefore capable of accurate control. On the other hand, equally well-made basic electric steel showed greater variation (in fluidity) and uniformity was more difficult to obtain. There was opportunity for a great deal of research into this subject. Referring to the influence of ladle height, the Authors said that in addition to their conclusions, the work of Briggs in America had proved that ladle height had little or no effect on fluidity determination. In reply to Dr. Elliss, they agreed that the physical characteristics (of the liquid steel) controlled the fluidity, but that these characteristics varied under different temperature conditions.

NOTES FROM THE BRANCHES

NEWCASTLE-UPON-TYNE.—On December 19, about 60 members visited the St. Peters Works of R. & W. Hawthorn, Leslie & Company, Limited. The party was welcomed by the works manager, Mr. D. G. Ogilvie. Guides conducted groups over the shops which made such an important contribution to the war effort. They produced engines amounting to over 1,000,000 S.H.P. for naval vessels, and over 90,000 S.H.P. for merchant ships. The boiler shops contain the most modern machines and ancillaries, also the latest electric welding equipment. The increased use of fabricated steel construction in marine engines, developed under the stress of wartime conditions, caused much discussion among the visitors.

The modern fitting and erecting shops are equipped to deal with the largest marine engine. The visit gave but a slight impression of the working activity, but the large engines seen in various stages of construction well showed the capacity of the firm. However, the quietness of the shops allowed close inspection of the engines, to what purpose the castings were put, their finished form and condition. The engines seen were of the Werkspoor, Doxford and Sulzer types. Their size came as a surprise to most of the foundrymen.

The foundry naturally received close attention from the visitors. The plant consists of one 5-ton cupola, a cupolette, and two Monometer tilting furnaces. The general arrangement and orderliness of the foundry evoked favourable comment, and many compliments were paid to the foreman, Mr. J. K. Meader, who gave a detailed explanation of how it was run. During the war, the plant switched over almost entirely to non-ferrous work; there was now to be a resumption of cast-iron production. The groups reassembled in the canteen where the firm provided tea.

In the course of a short speech, Mr. Ogilvie regretted that they had not been able to show everything under working conditions. He proceeded to give a short history of the firm, which went back 130 years, beginning at Forth Banks, Newcastle, extending to St. Peters and ultimately to the extensive shipbuilding yards further down the Tyne at Hebburn.

The visit concluded by a vote of thanks from the branch to the directors and management for the many courtesies extended to them that afternoon; their reception was most cordial.

LONDON.—The annual dinner of the branch was held at Pymm's Red House, Bishopsgate, on December 20, with Mr. G. R. Webster presiding. The function was quite informal, and the only guests were Mr. D. H. Wood and Mr. Tom Makemson, M.B.E., respectively the President and secretary of the Institute. The 120 members present enjoyed a simple but ample dinner, and a good cabaret concert. During the evening, after an address by Mr. Barrington Hooper, C.B.E., the members, by an overwhelming vote, were in favour of exploring the possibility of visiting Belgium in the spring. At a council meeting held prior to the dinner, Mr. W. G. Mochrie was co-opted a member, in the place of Mr. F. H. Hoult, who, now being located in the north Midlands, is joining the Sheffield branch.

MOLYBDENUM IN CAST IRON*

A. E. McRAE SMITH, M.A., B.Sc.†

From the engineer's, as well as the foundryman's point of view, the most important function of molybdenum in grey cast iron is to increase the tensile strength to a marked degree, without having to change normal cupola and other furnace practice, except that the phosphorus content must be really low. This marked beneficial improvement in strength can be attributed mainly to the direct solid solution effect of molybdenum on the matrix. The amounts added range from 0.30 to 1.2 per cent. for most applications.

Apart from this improved tensile strength, varying from 20 to 50 per cent., molybdenum also improves most of the other physical properties by which the quality of grey cast iron is normally assessed. The most important of these other improvements are as follow:—

(*a*) *Transverse Strength and Deflection.*—Molybdenum enables transverse strength to be improved without adversely affecting the deflection. This is unlke the effect of most other alloying elements, when an increase in transverse strength is normally accompanied by a decrease in deflection.

(*b*) *Hardness.*—Molybdenum in grey cast iron increases the hardness, but all other things being equal, that is, carbon and silicon contents as well as the section and size of the castings, this increase in hardness, even up to 30 or 40 points B.H.N., does not reduce the machinability. In other words, molybdenum-containing cast irons can be produced with machining qualities similar to non-alloy cast iron of 30 or 40 lower B.H.N.

(*c*) *Resistance to Impact.*—Although all types of high-strength grey cast irons must be classed as non-ductile materials, some grades exhibit considerably greater resistance to shock or impact, as measured by single-blow impact tests, than others. Molybdenum is certainly the most impressive alloying element to increase resistance to shock. Measured on the modified Izod unnotched 0.798-in. diameter bar, values up to 20 ft. lb. are usual, and in the acicular types values of 35 ft. lb. are not uncommon. This compares with a normal value of 14 to 18 ft. lb. for most other types of high-strength cast iron.

(*d*) *Resistance to Wear.*—Although it is always very difficult to compare with accuracy, the wear-resisting properties of one type of cast iron with another, there is no doubt that practical service results have shown that alloy cast irons containing molybdenum rank high on the scale. This excellent wear resistance is probably derived from the increased strength, toughness and higher hardness associated with molybdenum-containing cast irons. In addition to good wear resistance, some types of molybdenum cast irons are used for their improved resistance to "galling" or freedom from "pick up" and "scoring" under rubbing conditions.

(*e*) *Properties at Elevated Temperature.*—Molybdenum cast irons cannot be said to be very much better than ordinary grey cast irons as far as resistance to growth or true heat resistance is concerned, and this is probably due to the fact that molybdenum has only a very slight stabilising effect on the carbides. In spite of this, molybdenum has a very considerable effect in maintaining the strength of cast iron at higher temperatures. This is the reason why such cast irons are very often much more successful for hot-working dies and other tools than other types of alloy cast iron.

(*f*) *Machinability.*—This has been mentioned under "hardness" but it might be pointed out that the good machining properties of some types of molybdenum cast iron refute the general belief that machinability is directly proportional to hardness, as measured by the usual methods. The increased hardness obtained in molybdenum cast irons is derived from improved structural uniformity and not from the formation of carbides as is the case with certain other cast irons, *e.g.*, some types of chromium and nickel-chromium cast irons.

(*g*) *Suitability of Heat-treatment.*—Where pearlitic types of cast iron have to be heat-treated, either by ordinary quench and temper methods or by air hardening, to increase hardness and strength, molybdenum-containing cast irons, and particularly nickel-molybdenum cast irons are found to give the most reliable results and to be most responsive to normal treatment.

Molybdenum in cast iron acts very much in the same way as it acts in steel. Depth and degree of hardening is much greater and freedom from cracking reduced when molybdenum is present in cast irons which have to be heat-treated.

Types of Molybdenum Cast Iron

Quite a number of types of both grey and chilled cast iron are regularly produced in this country on a normal commercial scale. Although molybdenum is often used alone, combinations of nickel and/or chromium with molybdenum have found wider application.

The more commonly used types are as follow:—

(1) *High-strength Molybdenum Cast Irons.*—This is the most important group and cast irons of this type, containing molybdenum, are now widely used for a variety of applications.

When war-time requirements made it necessary to specify for special applications higher minimum mechanical properties than had been previously covered by the British Standard Specifications, a new grade was introduced calling for a minimum tensile strength of 25 tons per sq. in. on test-bars cast 0.875 in. dia. or 23 tons per sq. in. on test-bars cast 1.2 in. dia. Many foundries found it very difficult to meet this new specification with normal types of cast iron. Low-carbon types—*i.e.*, with carbon contents in the range 2.5 to 2.7 or 2.8 per cent., mostly produced in bath-type furnaces, could

*Abridged from an article appearing in "Alloy Metals Review," the house organ of High Speed Alloys, Limited, Widnes, Lancs.

†Keighley Laboratories, Limited.

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meet this new specification, without the use of alloys. Results, however, were in most cases found to be erratic and the founding properties of these low-carbon grey cast irons are very poor and lead to great difficulties in the foundry. Their regular production from cupola-melted metal is also a precarious business because it is difficult to melt even high-percentage steel scrap mixtures in a cupola to yield such low-carbon irons regularly and reliably.

It was soon found that the only certain method was to use molybdenum-containing cast irons, if the specified mechanical properties were to be obtained easily.

Pearlitic Types of Molybdenum Cast Iron

(*a*) *Straight Molybdenum.*—Cast iron of controlled composition was melted in both bath-type and cupola furnaces, and additions of 0.35 per cent. up to 0.60 per cent. molybdenum were made to get the desired properties, aiming at final carbon contents in the range 2.9 to 3.2 per cent. This higher carbon level ensures less risk of casting troubles and liquid shrinkage defects. Most of these straight molybdenum cast irons are inoculated or treated with late additions of ferro-silicon, or in the case of cast irons made by the Meehanite process, by additions of calcium silicide—*e.g.*, Grade GM. Meehanite.

A typical range of composition for castings varying in sectional thickness from about ¼ in. up to 3 in. would be as follows:—

T.C., 2.9 to 3.2; Si, 2.0 to 2.5; Mn, 0.7 to 1.0; S, 0.12 (max.); P, 0.15 (max.); and Mo, 0.4 to 0.6 per cent.

(*b*) *Nickel-molybdenum Cast Irons.*—A good many foundries preferred to use a combined nickel and molybdenum alloying addition where the nickel would range between 1.0 and 2.0 per cent., and molybdenum between 0.25 and 0.50 per cent. The nickel addition appears to give greater uniformity of structure and seems to allow for a slightly lower molybdenum content for equal mechanical properties. Also, a considerable number of foundries had already been producing high-strength cast iron by the Ni-Tensyl-Iron process to match B.S.S. 786 Grade 3, and a small addition of molybdenum increased the tensile strength sufficiently to bring the material safely into the Grade 4 class.

A typical compositional range for this type of high strength cast iron would be as follows:—

T.C., 2.9 to 3.2, Si, 1.6 to 2.0; Mn, 0.7 to 1.0; S, 0.12 (max.); P, 0.15 (max.); Ni, 1.4 to 1.6; Mo, 0.30 to 0.40 per cent.

(*c*) *Nickel, Chromium-molybdenum Cast Irons.*—For really massive and lumpy castings, *e.g.*, press and forging die blocks, forming tools for projectiles and the like, a small addition of chromium ensures that the material will be close grained in really heavy sections, say 3½ in. and over.

A typical composition in this class would be as follows:—

T.C., 2.9 to 3.2; Si, 1.4 to 1.7; Mn, 0.7 to 1.0; S, 0.12 (max.); P, 0.15 (max.); Ni, 1.8 to 2.0; and Cr, 0.4 to 0.8 (according to the mass of the castings), and Mo, 0.4 to 0.6 per cent.

(*d*) *Chromium-molybdenum Cast Iron.*—For certain applications—*e.g.*, engine liners, press sleeves, dies, large gear blanks, cams, etc., where wear resistance, in comparatively heavy section was considered the most important property apart from high strength, chromium-molybdenum compositions were used. A typical example, for castings from say 1½ to 4 in. general sectional thickness, would be as follows:—

T.C., 2.9 to 3.2; Si, 2.0 to 2.4; Mn, 0.8 to 1.2; S, 0.12 (max.); P, 0.15 (max.); Cr, 0.5 to 0.7; Mo, 0.6 to 0.7 per cent.

Acicular Type Nickel-molybdenum Cast Iron

During the war years Reese and Flinn, in the U.S.A., published a very interesting account of their work on nickel-molybdenum cast irons, in which they established a commercial process by which they could obtain cast irons exhibiting "acicular" structures in the as-cast condition, and proved that at least for low-carbon cast irons (2.50 per cent. carbon) such castings possessed superior properties to similar castings having the more normal pearlitic structure. The International Nickel Company, Inc. obtained a patent covering this process and a similar patent was obtained in this country by the Mond Nickel Company, Limited. A number of the foundries in this country are now known to be operating this process, using cupola-melted metal of normal carbon content, mainly in the range 2.8 to 3.1 per cent.

The Mond Nickel Company's patent (B.P. 545,102) states that, by their process based on correlating the compositions of the melt, the casting temperature, and the cooling rate, a cast iron is produced, with a microstructure consisting of needles of ferrite, in an austenitic matrix and that this type of cast iron possesses an excellent combination of mechanical properties.

In practice, it is known that mechanical properties well in excess of the minima specified for B.S.S. 786 Grade 4 can be regularly obtained.

The Author has seen many tensile tests, giving strengths from 23 to 27 tons per sq. in. *on test-bars cast 2.1 in. dia.* when the composition and cooling rate has been correlated for this size of test-bar.

Depending on the mass of the castings being produced, the nickel content will vary between 1.0 and 6.0 per cent. and the molybdenum content between 0.2 and 1.5 per cent., but for the majority of castings being produced in acicular cast iron in this country, it is understood that the nickel content will fall within the range of 1.50 and 3.50 per cent. and the molybdenum content is usually relatively constant at 0.70 to 0.90 per cent.

Apart from its higher strength, acicular cast iron, probably on account of its unusual matrix structure, possesses much greater toughness and resistance to shock than is the case with pearlitic types of high-strength cast iron, even those containing molybdenum.

Acicular cast iron is being used successfully for such applications as diesel, petrol-engine, and compressor crankshafts, camshafts (flame hardened on cams), press

and forging dies, and a wide variety of applications for highly-stressed components, where cast iron is used for its rigidity, damping capacity (or power to absorb vibrations), wear resistance, self-lubricating properties, and the like, and where a non-ductile material will prove satisfactory.

Special Types of Molybdenum-containing Cast Irons

(1) *High-carbon Cast Irons to Resist Thermal Shock.*—For certain applications engineers and plant manufacturers requires castings which will not readily "map line" or "crazy crack" when used under conditions where they are subjected to repeated severe thermal shock—*e.g.*, moulds for the die-casting of copper and other non-ferrous alloys, rollers and similar devices for the processing of sheet glass, moulds and shapes for glass, ingot, strip, and similar moulds for casting copper alloy billets, special type of brake drums, clutch plates, etc.

It has been well known for many years that high-carbon cast irons containing much graphite are more serviceable for such applications than low-carbon cast irons containing a comparatively small amount of graphite. The extra graphite present in the high-carbon cast irons, all other things being equal, allows them to accommodate their shapes to volume changes, without rupture of the surface, as seen when castings fail prematurely by "map lining" and "crazy cracks."

Unfortunately, cast irons with high graphite contents are prone to be weak and open grained and incapable of taking a good machined finish, especially in massive sections.

Experience has recently proved that these high-carbon cast irons can be greatly strengthened and provided with close-grained structures, by suitable additions of nickel, chromium and molybdenum. The latter element, in particular, helps to give extra strength to the matrix, and the nickel and chromium give the desired closeness of grain and good finish.

A typical compositional range for most castings would be as follows:—

T.C., 3.5 to 3.8; Si, 1.4 to 2.0 (according to sectional thickness); Mn, 0.6 to 0.9; S, 0.12 (max.); P, 0.10 (max.); Ni, 1.5 to 2.0; Cr, 0.3 to 0.6 (according to sectional thickness); Mo, 0.7 to 0.9 per cent.

A specialised application for this type of cast iron, particularly in the U.S.A. and Canada, is for brake drums of heavy duty lorries. The use of a high-carbon molybdenum-containing cast iron is claimed to eliminate failures from "heat checking." A typical specification would be as follows:—

T.C., 3.7 ± 0.10; Si, 1.30 upwards according to sectional thickness; Mn, 0.7—1.0; S, 0.12 (max.); P, 0.15 (max.); Ni, 2.0 ± 0.10 per cent.; Cr, 0.45 ± 0.05; Mo, 0.50 ± 0.10 per cent.

(2) *Chromium-molybdenum Cast Iron for Special Piston Ring Pots.*—A war-time specification (D.T.D. 485) covers a special type of piston ring pot castings where a hard structure, usually from chill-cast material, is obtained in the as-cast condition, and this is subsequently modified by heat-treatment to give a high transverse breaking strength, coupled with a high elasticity value. Castings of this type are specified to contain 0.8 to 1.2 per cent. chromium and 0.6 to 1.2 per cent. molybdenum.

(3) *Molybdenum in Cast Iron for Metal Working Rolls.*—In recent years molybdenum has taken a prominent place as an alloying element for improving the quality of most types of rolls for the metal-rolling industry. Its usefulness has been proved not only in chilled rolls but also in grain rolls and "indefinite chill" rolls. In combination with chromium and/or nickel it has found wide application in the U.S.A. and to only a slightly lesser degree in rolls manufactured in this country.

To give an example, for definite chill rolls, where higher strength in the neck is desired, without sacrificing hardness and depth of chill, a typical composition would be as follows:—

T.C., 3.0 to 3.3; Si, 0.5 to 0.6; Mn, 0.20 to 0.40; S, 0.08 (max.); P, 0.10 to 0.20; Ni, 4.0 to 4.5; Cr, 1.2 to 1.4, and Mo, 0.3 to 0.5 per cent.

For a typical grain roll a suitable composition would be:—

T.C., 2.5 to 2.7; Si, 0.9 to 1.1; Mn, 0.3 to 0.4; S, 0.08 (max.); P, 0.10 to 0.20; Ni, 1.0 to 2.0; Cr, 0.5 to 0.8, and Mo, 0.4 to 0.5 per cent.

The above compositions are merely given as examples, but there are many others where up to 0.5 per cent. or more molybdenum is added for its strength-giving, and grain-refining properties.

Production of Molybdenum-containing Cast Irons

All the ordinary types of molybdenum-containing cast irons can be produced by ordinary methods. Melting can be carried out in any normal type of furnace, electric, rotary, crucible or cupola. This cupola gives excellent results, if the melting is carried out under proper control. Where high-strength properties, as in acicular and pearlitic molybdenum cast irons, are required, the cupola can be used with little fear of erratic results, since really high-strength material can be produced at total carbon levels in the range 2.9 to 3.2 per cent.

One point which is often overlooked by founders is the fact that the phosphorus content of molybdenum containing cast iron must be really low, if the best results are to be obtained. As a general rule the phosphorus content should never exceed 0.15 per cent., and for preference should be lower. It has been established by certain investigators in the U.S.A. that molybdenum and phosphorus form a complex metallic compound when the phosphorus content is over 0.12 or 0.15 per cent., the exact limit depending on the other elements present in the cast iron. Above this figure the excess phosphorus neutralises the effect of part of the molybdenum addition. Stated another way, where the phosphorus content is in excess of probably 0.12 per cent., it forms a compound with molybdenum thus impoverishing the matrix of this latter element. It can readily be seen that when the total addition of molybdenum is in the range of 0.2 to 0.4 per cent., it would be possible for the whole of the molybdenum to be neutralised by the phosphorus, and the expected increase in tensile strength and other properties fails

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to materialise. Many early users of molybdenum in cast iron fell into this trap.

One of the great advantages in the production of molybdenum cast irons, particularly those of the acicular type, is the wide latitude in silicon content which is permissible without adversely affecting the physical properties. This means that a very satisfactory carbon-silicon ratio can be maintained, even in castings of comparatively heavy sectional thickness. This in turn ensures good casting properties. At a carbon level of, say, 2.9 per cent., silicon contents up to 2.5 per cent. or even 3.0 per cent. can be used without unduly coarsening the structure.

Molybdenum-containing cast irons, including acicular types, can be handled in the foundry in exactly the same way as other types of good quality alloy and non-alloy cast iron. Green and dry sand moulds and cores may be used in the usual way and standard designs of runner systems and self-feeding methods are effective.

HOUSE ORGANS

Bulletin of the Association of Bronze and Brass Founders, No. 5—October and November. This issue is extremely interesting: in several places there is posed the query as to whether there should not be "closer association with the ferrous sections of the industry in order that employers' organisations could unify some of their activities." There is a note that the council has agreed to give a donation of 50 guineas to the British Standards Institution. The Association is to co-operate with the British Non-ferrous Metals Research Association in carrying out experimental work in connection with the cutting of test-pieces from castings as is to be recommended in the forthcoming publications, "Code of Procedure in the Inspection of Copper-base Alloy Castings." As recent experience inclines to the belief that crucible life is not now equal to pre-war, the question is being taken up with the crucible manufacturers' association. A new feature has been introduced in which abstracts of some of the more interesting articles and Papers, which have appeared in recent issues of the technical Press, are printed.

Metal Powder Report, Vol. 1, No. 2, for private circulation. Published by Powder Metallurgy, Limited, Commonwealth House, 1-19, New Oxford Street, London, W.C.1. A striking editorial showing the essential differences between orthodox and powder metallurgy opens this second number, which follows the layout established in the first edition. Once again the abstracts have been well chosen from an exclusive field.

One Hundred and Eleven, Vol. 7, No. 7. The staff magazine of the Hammond Lane Foundry Company, Limited, 111, Pearse Street, Dublin. This is essentially a staff magazine and, as is usual in such cases, some of the quips are too cryptic to be understood by the general public. As usual, it contains some good stories and fresh jokes.

BRAZILIAN DUAL-PURPOSE FOUNDRY

The dual-purpose foundry now being completed at Volta Redonda has, according to the Monthly Statistical Bulletin of the British Iron and Steel Federation, attracted some attention in the U.S.A., where it has been described as one of the most completely equipped in the Western Hemisphere. It houses under one roof installations usually operated separately. Half the space is devoted to highly mechanised systems for the regular supply of ingot moulds and stools. The other half is primarily for the production of castings for plant maintenance, having facilities and equipment for producing any casting likely to be required in the whole plant.

The equipment consists of 2 air furnaces of 25 tons; 2 cupola furnaces, 66 in. dia.; 2 electric furnaces; 2 crucible furnaces; 2 Detroit electric furnaces (alloy iron and non-ferrous) of 1,250 lb. capacity; 3 annealing furnaces (car type); 2 general purpose ovens; a set of ovens for ingot moulds (pit type); 2 core ovens; a sand-conditioning system (capacity, 30 tons per hr.); blast rooms, belt conveyors, etc., and roll-turning lathes, machine shop. The cost of the foundry is £462,500, while it will have a capacity of 30,000 tons per annum.

Annual capacity of the foundry on completion is expected to be, in net tons:—Alloy steel rolls, 600; alloy iron rolls, 320; chilled iron, 130; steel castings, 1,500; grey-iron castings, 1,350; alloy iron, 150; ingot moulds and stools, 7,000; non-ferrous castings, 150.

The jobbing nature of the foundry's operations will require it to be, in addition to an ingot-mould foundry, a steelfoundry one week, an ironfoundry the next, and perhaps a rollfoundry the following week. This gave rise to the requirement that, in addition to the charging of the cupola, the arc furnaces and the air furnaces would need to be charged at various times both with cold charges and with hot charges for duplexing. The laayout is designed so that ingot moulds may be poured with hot metal direct from the o.h. mixers. In the design of the foundry, allowance has been made for its easy expansion to provide an additional 150 per cent. capacity.

OLD STAGERS

It was wise on our part to insert "E. and O.E." in the note published under the above heading in a recent issue, as we half expected we had omitted some names. Thus, Mr. A. E. McRae Smith has been kind enough to point out to us that Mr. H. Curnow, director and foundry manager of Rudge Littley & Company, Limited, West Bromwich, joined the Institute in 1906.

Through the courtesy of Mr. James Timbrell, we now add to the list the name of Mr. R. D. Welford, who joined the Institute of British Foundrymen in 1908. After years of service with the Yorkshire Light Repetition Foundry Company, Limited, he is now enjoying good health in retirement.

We express to Mr. Curnow and Mr. Welford our apologies for our oversight.

ART AND MYSTERY OF THE FOUNDRYMAN

SIR ALFRED HERBERT'S STATEMENT

We reproduce below a statement made by Sir Alfred Herbert, past-president of the Institution of Production Engineers, on the subject of iron castings supplies. Editorial comment upon these observations is to be found on page 1 of the current issue.

Munitions of war make little demand on the iron-foundry. There are no iron castings in guns, rifles, ammunition or bombs, and only a very small proportion in aeroplanes, tanks and naval equipment. Very naturally, therefore, our foundries were neglected in wartime, and many foundrymen left their jobs under the attraction of other branches of engineering where, after a very short time, higher wages could be obtained on simple repetition jobs. Apprentices who would normally have taken up foundry work were similarly diverted.

Now we have returned to the arts of peace, and here the demand for iron castings is proportionately enormously higher. In a machine tool, for instance, at least 75 per cent. of the total weight consists of cast iron, and in many other branches of engineering the percentage approaches this figure.

We engineers, therefore, find ourselves confronted by a most unfortunate and unprecedented set of circumstances, and unless we can find some relief our output must remain limited. On the one hand, the demand for castings (and good ones at that) is greater than ever before, and the sources of supply very much less. By and large, our foundries are as numerous and their capacity as great as before the war, and the whole difficulty is that adequate labour does not exist.

Besides the drain on foundry labour during the war, we have to realise that certain psychological factors are at work which are discouraging moulders who have left the trade from returning to their jobs, and are similarly discouraging apprentices and labour from entering the foundry trade.

Industrial Snobbery

We hear a good deal about snobbery, which is generally laid at the door of what used to be known as the "privileged classes"—dukes, for instance. Actually the sin of snobbery is far more prevalent among the various grades of workers in industry. We know how often the black-coated worker is liable to fancy himself superior to the manual worker, or how the machine operator or fitter thinks his job more important than that of the moulder, who is supposed to spend his life merely in digging holes in black sand and getting rather dirty in the process, and who is thought to possess less skill and ability than the mechanic.

This is a totally wrong and perverted view, for a moulder who knows his job from end to end possesses a degree of craftsmanship unexcelled by the workers in any other branch of the trade. The moulder has to know his materials—sand and its treatment—the art of core-making, and he must know something about metals—their mixtures and treatment—and when he makes a scrap casting (not a very rare event, unfortunately), he should know the reason why. He should understand enough about pattern-making to be able to criticise his patterns intelligently, and, above all, he must realise that hot metal has its dangers, and that carelessness in its use may involve risk to himself and to his mates.

Modern foundries are moving more and more towards mechanisation and the use of elaborate machines for moulding, sand preparation, and for fettling. The moulder's job, it is true, involves harder work and blacker hands than that of the average mechanic, but reasonably hard work hurts no one, and black hands are quickly cured by the use of the washing facilities which are almost invariably available to-day, and black sand washes off more easily than grease and oil. Much greater attention is being paid to reducing dust and to improving generally the conditions under which foundry work is carried on. It is the invariable experience of apprentices who have transferred—perhaps at first somewhat reluctantly—from the machine shop to the foundry, that the work is of absorbing interest.

The proud mechanic must realise also that without an adequate supply of castings he would soon be out of work; that he depends, in fact, directly on the skill and industry of the moulder for his daily bread.

Suggested Remedies

In a somewhat desperate effort to meet the difficulty, a good many engineers are substituting castings in aluminium alloys for iron castings. Wherever these can be used for elements which are in motion the saving of weight is helpful, but in many cases (particularly in machine tool work) weight in the frames, beds and bodies of machines is a distinct advantage for reasons of stability and for reducing vibration.

Another direction in which relief is being sought is in the use of fabricated steel frames instead of castings, but this field is a limited one.

As regards the long-term policy, foundry owners must endeavour to improve the position by still further mechanisation and by making their foundries more attractive. Regarding the short-term position, which is indeed becoming desperate, the only solution is to increase the immediate supply of labour, and it must be remembered in this connection that owing to age and death there is inevitably a continuous wastage to be made up.

Serious thought is now being given to obtaining castings from the Continent, where large productive capacity exists, and before very long it is probable that some supplies of castings will be reaching us from this source. It is, however, a remedy which is not without its drawbacks. It means sending money abroad, which is quite contrary to national policy, instead of spending it at home.

Another solution, and a better one, is the employ-

Art and Mystery of the Foundryman

ment in British foundries of existing and available foreign labour—German, Polish or Italian—which would give great help in our immediate difficulties. But although the trade unions have agreed "in principle" to the employment of this labour, there is still great local resistance to it, which is extremely unwise in view of the dependence of all other classes of labour on an adequate supply of castings. Probably these unwarranted objections will be overcome when the situation becomes more clearly realised by the workers. Let us hope that this will happen before it is too late.

Administrative Ability

The higher positions in the foundry industry demand, of course, not only a knowledge of the craft, which can only be gained by actual foundry experience, but at least a working knowledge of chemistry, metallurgy and combustion, to say nothing of administrative ability and knowledge of human nature.

The supply of young men available to fill these positions is entirely inadequate, but it is certain that for as long as one can reasonably see into the future, there will be abundant opportunity in foundry work for men possessing the necessary qualifications.

The Institution of Production Engineers is doing much to improve the situation by having Papers read and lectures given on foundry work throughout its many sections, not only on the technical aspect, but on its vital economic importance to industry. The Institution can also exercise its great influence on the directors of technical colleges by impressing on them the necessity of providing classes in subjects relating to foundry work, particularly in metallurgy and chemistry of cast iron. I am glad to say that the Coventry Technical College is taking this step.

From my own experience of over 60 years since I completed my apprenticeship, I have never ceased to regret not having had the opportunity of spending some time in the foundry when I was a young man, and I know of a great number of other engineers who share my views.

NOT A NECESSITY BUT AN ADVANTAGE

BY "CHIP"

Cores are used extensively in the foundry because it is impossible to produce castings of certain designs without their aid. There are cases, however, in which cores are used not because of necessity, but because of expediency. Cores possess certain advantages, and then their use is adapted whenever the added expense of making and drying justify their production.

A specific case illustrating the above concerns a small brake race of special design. This casting was about 15 in. external diameter, 2 in. deep, and carrying a number of teeth, as shown in Fig. 1. Also, at certain fixed places, bolt-holes had to be drilled in the casting for securing to the side of a fabricated steel drum.

The design of this casting was such that if taper was allowed on the face of the teeth to enable them readily to leave the sand, an excessive amount of chipping would be necessary in the fitting shop to enable the pawl to engage the whole width of the tooth. Also this taper tended to encroach on to the position of the holes, so that extra chipping had to be done here as well to enable the heads of the nuts to sit in position.

To produce castings giving the minimum of trouble to the user, should be the aim of the foundryman, and so in this case, as a large number were required, a core was used to form the teeth, the pattern being as shown in Fig. 2, where A is the casting, B, the coreprint and core, and C, one of a number of moulders' brads placed at intervals through the core, thus securing it to the pod of sand D.

To eliminate the taper in the core, a ring box was made, as in Fig. 3, in which the teeth were placed in sections. These were jointed in such a manner that on the withdrawal of the main portion of the box X, the pieces forming the teeth Y could be subsequently withdrawn in the direction Z, thus taking advantage of the taper of the design and not demanding any in the other direction, as would be necessary if the job was moulded off a pattern.

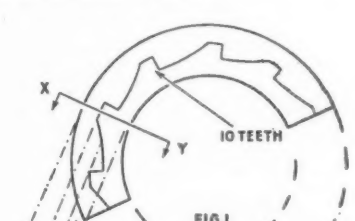


FIG. 2

FIG. 3

Another advantage of this method is that the teeth being formed in a core, they are virtually cast in a dry sand mould, and thus produce a sounder job than if cast green of a pattern.

ENGINEERING AND METALLURGY IN THE '47's

By G. J. S. KING

Among the celebrities whose names occur in the centenaries of 1947 are several who are a personal memory to a wide public. Such, for example, is that great metallurgical chemist and ironmaster, Thomas Andrews, who was born on February 16, 1847. He succeeded his father as proprietor of the Wortley Iron Works, was metallurgical consultant to the Admiralty and Board of Trade, and was a zealous pioneer in the advocacy of technical education.

Andrews determined the relative corrosibility of wrought iron and modern steels in sea-water and in tidal streams, demonstrating that iron corrodes much less than steels. He studied the influence of sudden chilling on the physical properties of metals, and wrote on "Electro-chemical Effects on Magnetising Iron" and also on the "Passive State of Iron and Steel." He also determined the relative passivity of the various modern steels, and the influence of chemical composition, physical structure, etc., on the passivity of metals, and experimented on the "heat dilation of metals from very low temperatures." He was, moreover, patentee of an invention for hydraulic machinery in connection with the manufacture of iron.

First Compound Marine Engine

One month after Andrews—on March 17—Sir Alexander Kennedy was born. Early in his career he worked out the designs for the first compound marine engines built on Tyneside, and subsequently became Professor of Engineering at University College, London, where he inaugurated an engineering laboratory—the first of its kind in England. Here he experimented on marine engines, and on the strength and elasticity of materials. He designed the steel and concrete internal structure of the Alhambra Theatre, and collaborated with Bryan Donkin in exhaustive experiments on steam boilers. His subsequent work was chiefly in electrical research.

Among a host of other celebrities born in 1847 were some of direct or indirect interest to the foundry trade, notably:—Alexander Siemens (January 22), who was a member of the famous engineering firm, and became president of the Institution of Civil Engineers; Viscount Pirrie (May 31), the famous shipbuilder, whose career synchronised with modern steel shipbuilding and progress in marine engineering; Palin Gurney (September 7), scientist and mineralogist, who was a founder of the Crystallogical Society, and also of a department of mineralogy and crystallography at the Durham College of Science (Armstrong College); the third Marquis of Bute (September 12), who completed the work of his father in making Cardiff the largest coal-exporting port, and in the construction of the Bute Docks; and Archibald Liversidge (November 17), mineralogist and metallurgist, who founded a School of Mines at Sydney (where he became Professor of Chemistry and Mineralogy in the University).

That famous metallurgist, David Mushet, died on June 13, 1847. He was one of the foremost authorities in Britain on the manufacture of iron and steel, and built the Calder Iron Works, discovering, in doing so, the "Black-band Ironstone," the economic use of which he demonstrated. Among his inventions which assisted in improving the methods of manufacturing iron and steel were the preparation of steel from bar-iron by a direct process, the extraction of iron from cinder, and improvements in the process of puddling iron.

Conservation of Energy

In the previous year, that famous physicist, James Prescott Joule, had written a Paper on the "Effects of Magnetism upon the Dimensions of Iron and Steel Bars," and in 1847, his popular lecture on "Matter, Living Force, and Heat," described the fundamental principles of the doctrine of the conservation of energy. At the British Association meeting at Oxford that year Joule gave an account of his researches in regard to the relations between heat, electricity, and mechanical work. Joule's Paper, vital though it was, would not have been discussed had not a young man arisen and "by his intelligent observations created a lively interest in the new theory." The young man was William Thomson (later Lord Kelvin), whose close friendship with Joule began from that time. The publication in the same year of Helmholtz's famous work on the "Conservation of Energy" was another spur to Kelvin in his researches on the problems of heat.

On October 1, 1847, work began in the famous Armstrong works at Elswick, the first pay sheet totalling £9 17s. 10d. Thomas Hawksley, in conjunction with W. G. Armstrong, invented that year a self-acting valve designed to close the pipe automatically when the velocity of the water passing through exceeded a certain limit. William Tierney Clark was then building the great suspension bridge at Budapest. There was a royal commission to inquire into the application of iron to railway structures (of which Eaton Hodgkinson, famous for "Hodgkinson's beam," was a member). That great metallurgist, (Sir) William Siemens, preceded his more important invention of the regenerative furnace by patenting his regenerative steam engine and condenser; and Du Buisson took out a patent for obtaining paraffin.

That famous metallurgist, John Percy (author of the first great modern treatise on metallurgy, and the inspirer of the Thomas-Gilchrist process for making Bessemer steel from iron ores containing phosphorus) became that year a Fellow of the Royal Society; Bennet Woodcroft (who rescued Symington's marine steam engine from oblivion) became Professor of Machinery at University College, London; Charles Bradlaugh, the freethinker, became clerk to a coal merchant; and James Beaumont Neilson (inventor of the hot-blast in iron manufacture) retired from business four years after an infringement of his patent had resulted in that *cause célèbre*, Neilson *v.* Baird.

(*Continued overleaf, column* 2.)

BOOK REVIEWS

Transactions of the American Foundrymen's Association, Vol. 53. Published from the Association's Headquarters at 222, West Adams Street, Chicago, Ill., U.S.A.

This is the first edition the reviewer has seen since the format was altered, and being a little old fashioned perhaps, prefers to see the pre-war style. "A good wine needs no bush," and similarly high-grade Papers need no showmanship to make them acceptable to technically-minded individuals. It was only natural for the reviewer to turn first to the British exchange Paper, and herein he found, after some difficulty with the pagination owing to the "bleeding" of illustrations which precludes orderly numbering, that a micro and a radiograph are set "skew-whiff" to catch the eye. There was a dignity about the pre-war style, which is retained only in the first 38 pages of the volume under review. For the actual contents, it is pleasing to be able to state that they are uniformly excellent, and Schwartz's lecture on the "Solidification of Metals" is an outstanding contribution to the literature of cast metals. These transactions contain about 70 technical Papers and committee Reports, but virtually no discussions—a feature to be deplored, because in the past they disclosed inaccuracies, weaknesses, brought into relief cardinal points, and indicated the directions for future work. The reviewer is conscious that his views on the make-up of the proceedings of technical societies may be quite different from the bulk of American opinion and, after all, that is the public for which the management of the A.F.A. has to cater.

V. C. F.

Engineering Radiography. Published by Emmott & Company, Limited, 31, King Street West, Manchester, 3. Price 2s. 6d. net.

The anonymous author of this little monograph has very clearly set out the underlying principles of the radiographic inspection of engineering components. He has followed up this by detailing the requirements and operation of X-ray apparatus. On the question of interpretation of radiographs, the author wisely stresses the need for the co-operation of the metallurgist and other interested parties until such time as the operator has become really expert in diagnosis.

Gamma rays, with their greater penetrative power, next come in for consideration, and in this connection there is still a lack of data for time exposures for various substances. The author's pet subject is obviously crystal analysis technique, and though this field is still mainly confined to the research laboratory, it is rapidly becoming a useful tool. There is a useful chapter on applications, in which castings, welded joints, building materials and plastics are all surveyed.

The book can be recommended as a reliable introductory study of the subject, and it should be of real use to students.

V. C. F.

(*Continued at foot of next column.*)

ENGINEERING AND METALLURGY IN THE '47'S

(*Continued from previous page.*)

Cast-iron Factory

James Bogardus constructed in 1847 a factory at New York entirely of iron—the first cast-iron building in the United States. Meyer Guggenheim settled in America that year, and acquired there copper interests, building up a mining and metallurgical business which controlled at one time nearly half the world's copper output. There were published that year Edward Cresy's "An Encyclopædia of Civil Engineering," Robert Fox's "Some Remarks on the High Temperature in the United Mines," and James Hann's "Treatise on the Steam Engine."

Incidentally, it was in 1747 that Richard Ford succeeded in smelting iron ore with pit-coal at Coalbrookdale. A Paper by the "Rev. Mr. Mason," Woodwardian Professor at Cambridge, given in the Philosophical Transactions for that year, stated: "Several attempts have been made to run iron-ore with pit-coal: he (Mr. Mason) thinks it has not succeeded anywhere, as we have had no account of its being practised; but Mr. Ford, of Coalbrookdale, in Shropshire, from iron-ore and coal, both got in the same dale, makes iron brittle or tough as he pleases, there being cannon thus cast so soft as to bear turning like wrought-iron."

LATEST STATISTICS

The Statistical Bulletin of the British Iron and Steel Federation for November shows that the output of steel castings was, during October, 1946, 7,300 tons, as against 7,200 in the previous month, and 7,100 tons in October, 1945. The actual weekly averages of deliveries were, for the same periods, 3,200, 3,000 and 3,000 tons. The average number of people at work in the steelfoundries was, during the week ending September 7, 1946, 18,467, compared with 22,027 in 1945. Ironfoundry statistics for the same weeks showed 124,091 in 1946, as against 99,709 the year before. This gain of 24,382 is made up of a loss of 926 females, and a gain of 25,308 men. From this it would appear that some attention should be given to including the fair sex in the propaganda drive. The importance of this will be readily recognised by the statement that females represent practically 10 per cent. of the total labour force. *Avanti signoritas*!

(*Continued from previous column.*)

Philips Resistance Welding Handbook. Published by Philips Industrial (Publications Department), Century House, Shaftesbury Avenue, London, W.C.2. Price 11s., post free.

This is a companion volume to Philips Practical Welding Course, which deals with arc welding. Of simple character, the book is written to help those concerned in the actual carrying out of production jobs. Though there is an extensive literature on welding, there are not too many text books, and this one certainly makes a most useful addition. It runs to 210 pages, is well illustrated, and solidly bound.

OBSERVATIONS ON SOME SURFACE PROPERTIES OF VITREOUS ENAMELS*

By W. E. BENTON, M.Sc.

There are two surface qualities of vitreous enamel which receive only slight attention in the technical literature. They are perhaps noticed more by the purchaser than the manufacturer. A woman buying a gas cooker expects the enamelled surfaces to be very smooth and easy to clean, and when clean she likes the enamel to look bright and glossy. Resistance to corrosion and abrasion may be more important qualities, but assuming that the maker has taken care of these the purchaser's satisfaction will be all the greater if her enamel is smoother and more brilliant than her neighbour's.

The Author has chosen the word "brilliance" instead of "gloss" or "lustre" with which it is frequently identified, because at one time English vitreous enamel was associated inseparably with the quality of brilliance. In 1781, Horace Walpole, describing the prose of the historian Edward Gibbon, compared it to "brilliant enamel." He was most certainly thinking of the snuff-boxes and candlesticks, étuis and wine-labels fashioned at Bilston and Birmingham and Battersea out of thin copper, covered with white enamel, decorated with finely engraved transfer-prints or paintings in bright colours, and beautifully mounted in chased copper frames, double-gilt.

Walpole himself collected these enamels and gave pieces as presents to his friends[1]. When he used the word "brilliant" he probably meant (according to Samuel Johnson, his contemporary), "having lustre, or splendour." Lustre is frequently used in the same sense today.[2] The word "splendour" has a grand Johnsonian flavour. It scarcely seems to apply to the vitreous enamels of to-day.

The Author will first assume that what is commonly meant by brilliance is identical with "gloss" which in this industry is measured by the coefficient of specular reflection. When light is incident on a vitreous surface, part is reflected and part transmitted. The intensity of the reflected ray is affected by the direction of the incident vibration, with respect to the plane containing the incident ray and the normal to the surface at the point of contact. If the vibration be in this plane, which is called the plane of incidence, the reflected intensity is in general less than if it were perpendicular to it. There is an angle of incidence, known as the polarising angle, at which the reflected intensity in the plane of incidence is wholly or nearly extinguished, and the reflected ray consists of waves vibrating only at right angles to the plane of incidence.

This fact can be made use of to discriminate between light reflected at the surface and light emerging from it after scattering by refraction or diffraction. The proportion of the intensity of the incident light reflected from a perfectly plane surface of a perfectly transparent medium of refractive index 1.50, is shown in Fig. 1, plotted against the angle of incidence. Three

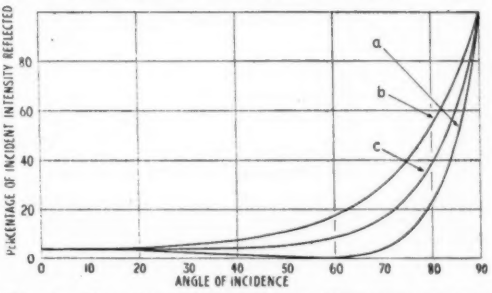


FIG. 1.—THE PROPORTION OF THE INTENSITY OF THE INCIDENT LIGHT REFLECTED FROM A PLANE SURFACE OF A PERFECTLY TRANSPARENT MEDIUM OF REFRACTIVE INDEX 1.50.

curves are shown corresponding to monochromatic light:—(*a*) polarised in the plane of incidence; (*b*) polarised perpendicular to that plane, and (*c*) not polarised, the direction changing at random from moment to moment.

Case (*c*), the coefficient of reflection for ordinary light, is given by:—

$$\frac{1}{2}\left\{\frac{\sin^2(i-r)}{\sin^2(i+r)} + \frac{\tan^2(i-r)}{\tan^2(i+r)}\right\} \quad \text{(i)}$$

where i is the angle of incidence, and r the angle of refraction. This expression is the arithmetic mean of cases (*a*) and (*b*).[3]

It will be noticed that curve (*b*) rises steadily from

* A Paper presented to the annual conference of the Institute of Vitreous Enamellers.

1 Horace Walpole to Richard Bentley, Sept. 18, 1755.

2 Unfortunately it also has a special meaning for certain metallic glazes

3 Sometimes called Fresnel's Law of Reflection.

Surface Properties of Vitreous Enamels

a minimum of 4 per cent. at normal incidence to 100 per cent. at grazing incidence. Curve (*a*) starts at the same figure, because when the light is normal the plane of incidence has no meaning, and drops to zero at the polarising angle, in this case 50 deg., afterwards recovering to 100 per cent. at grazing incidence. At the polarising angle the reflected and transmitted rays are at right angles.

For ordinary light, case (*c*), the intensity remains almost constant from 0 to 40 deg., and then rises rapidly to 100 per cent. at grazing incidence. The gloss of a piece of plain polished glass is therefore very low when viewed normally or at any angle less than 40 deg., but rises rapidly to perfect reflection at extreme oblique incidence. A plate glass window makes a poor mirror, but even the dullest flat surface looks brightly polished at grazing incidence. Even lamp-black is a reflector when viewed obliquely.

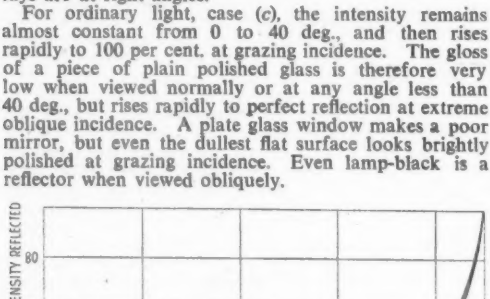


FIG. 2.—UNPOLARISED INTENSITY CURVES.

The gloss of a surface varies with its refractive index n ($= \sin i/\sin r$). At normal incidence, expression (i) reduces to :—

$$\frac{(n-1)^2}{(n+1)^2} \quad .. \quad .. \quad .. \quad \text{(ii)}$$

In Fig. 2 are shown the unpolarised intensity curves for media of refractive index 1.5 (crown glass), 2.0 (zircon) and 2.5 (approximately diamond). The gloss at normal reflection rises rapidly from 4 per cent. for crown glass to 18 per cent. for diamond. If a number of transparent gem-stones are arranged in order of brilliance (as commonly accepted by jewellers), it will be seen that they are also in order of refractive index. (Table 1.) It was at one time believed that they were also in order of density, but this relation, although remarkably consistent for a number of stones, is not general (Fig. 3). Diamond itself is a notable exception, having a refractive index far higher than its density would suggest, and most flint glasses have lower indices than gems of the same density. The relation between refractive index and composition is important to the glass industry and has been the subject of prolonged research, which in recent years has had a measure of success.[4]

TABLE I.—*Gem Stones Arranged in Order of Brilliance.*

	Refractive Index.
Diamond	2.42
Zircon	1.93
Almandine	1.78
Kyanite	1.71
Malachite	1.66
Jadeite	1.65
Tourmaline	1.62
Nephrite	1.61
Beryl	1.57
Quartz	1.54

For the frit-maker, who wishes to increase the gloss of his enamel four-fold, there is little comfort. The great majority of enamels have refractive indices between 1.50 and 1.55, corresponding to a gloss at normal incidence of only 4.0 to 4.6 per cent. The finest "strass," used for paste diamonds, has an index not higher than 1.7, corresponding to a normal gloss of 6.7 per cent. Yet the brilliance of a fine piece of strass can deceive everyone except a jeweller or a connoisseur. The calculated figures for gloss assume a perfect surface. True values frequently fall far short of the theoretical. The many components of enamels which are known to make them more brilliant do so to a small extent by raising the refractive index, and to a much larger extent by improving the surface. Many a potter has wished that his final glazed piece would look as well as the same piece does in the unfired state after dipping in a clay slip. The refractive index of water is only 1.33, but its surface is perfect and the smooth curves of the wet clay have a wonderful soft brilliance. Smoothness and brilliance are complementary.

It may seem remarkable that surface reflection depends on the refractive index, that is, upon the ratio of the velocities of light in the two media. The electromagnetic theory explains this by showing that at the boundary the electrical forces outside must balance those inside, and the force inside is determined partly by the velocity of light in the medium. That the reflecting medium controls the reflection is also shown by the fact that the reflected light takes the colour of the medium. Blue glass reflects only blue light. This again is due to the disturbance in the balance of forces at the boundary if certain wave-lengths are absorbed.

It may be noted here that although the refractive index, and consequently the gloss, of an enamel matrix can be raised to only a limited extent by varying the composition, use is made of the high refractive index of the oxides of antimony, tin, zirconium and titanium to increase the light reflected from below the surface. Other things being equal the opacifying power of particles of refractive index n_2 in a matrix of index n_1, may be assumed to be proportional to the coefficient of normal reflection:—

[4] See, for example, G. W. Morey. "Properties of Glass"—1938.

$$\frac{(n_2-n_1)^2}{(n_2+n_1)^2} \quad .. \quad .. \quad .. \quad (iii)$$

It has been shown that gem-stones arranged in their commonly accepted order of brilliance are also in order of refractive index, and therefore of their coefficient of specular reflection, which in the vitreous enamelling industry defines "gloss." There is good reason, therefore, for identifying brilliance with gloss. But by measuring gloss as a physical quantity one is apt to forget that all these words, "brilliance," "lustre," "splendour" and "gloss" describe sensations. The difference in brilliance between a piece of enamel and an amethyst is the difference between two sensations. If the word "gloss" is retained to define a physical quantity, and brilliance is regarded as the measure of a sensation, then the difference between them is similar to the difference between loudness (a sensation) and intensity (a physical quantity) in music, or between pitch and frequency. By Fechner's law, equal arithmetical differences in sensation are caused by equal ratios in the related physical quantities. The eye regards as equal increments in brilliance a series of gloss factors having measurements in the ratios of 1, 2, 4, 8 . . . . . , or 1, 3, 9, 27 . . . . . This goes far to explain the curious fact that substances having such differences in gloss as diamond and strass should be so easily confused except by experts.

It is curious to compare the claims for brilliance made in text-books on behalf of (*a*) transparent plastics, (*b*) glass, (*c*) imitation gems, and (*d*) real gems. The transparent acryllic resins have an index of refraction of about 1.5, equal to that of ordinary crown glass. It is surprising that anyone should imagine that the brilliance of a plastic can equal that of flint glass. At the "Britain Can Make It" Exhibition, one has the opportunity of comparing these two materials almost side by side; the difference in brilliance is very noticeable.

It is significant that the French used the words "éclat" and "éclatant" for brilliance and brilliant, words which again suggest a sensation rather than a physical quantity. In the appreciation of a transparent stone or piece of glass only four optical phenomena can be involved:—(*a*) Brilliance, due to surface reflection; (*b*) colour, due to selective absorbtion; (*c*) "fire," due to internal reflection and refraction (by cutting a diamond in a certain way all the light can be returned), and (*d*) spectrum colours, due to dispersion.

In glazed materials such as enamel and porcelain brilliance and colour are evident but no dispersion. In place of "fire" there is opacity. Allied to both opacity and brilliance there is a curious optical quality, or group of qualities, found in some degree in all glazed materials, for which no name has been found, and which even artists and collectors find difficulty in describing. They are the qualities which enable them to discriminate between hard and soft porcelain, between European and Chinese, between real and counterfeit. Some glazes are described as "cold," others as "warm" or "soft." Chelsea porcelain has been compared to "frozen snow." The Chinese use for highest praise the expression "like congealed lard." There is a possibility that if makers could invest gas cookers and washing machines with these curious attributes they might sell for tremendous prices and might be found more often in museums than in kitchens. Anyone who studies ceramics at all is soon impressed with the real nature of these indefinable qualities. The same pieces have been admired and valued by people of every nation and over a space of many hundreds of years. The desired qualities are independent of shape or colour or style of decoration. Many of the most famous pieces are of the simplest shapes with scarcely any decoration.

Without attempting to define what it is that has such a powerful æsthetic appeal, the characteristic is undoubtedly a complex one. The eye (or the brain) appears to tire, even in a glance lasting only a few seconds, of a dead level of uniformity. That passionless perfection so loved by Staffordshire potters is anathema to the artist.

The eye appears to like complicated sensations such as are created by an opacity varying in intensity with

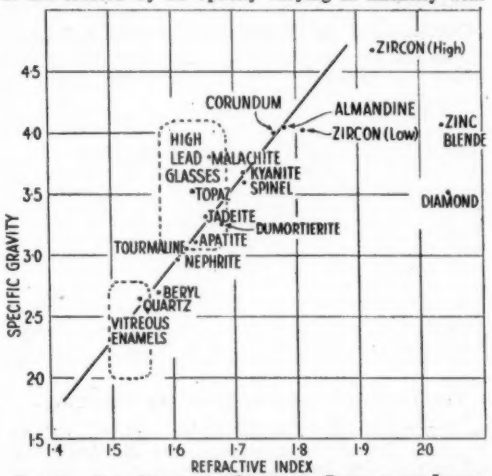


FIG. 3.—GEM STONES IN ORDER OF REFRACTIVE INDEX AND BRILLIANCE.

depth, or by a surface exhibiting variations on a minute scale in colour and brilliance. Simple materials, such as a perfectly opacified glass without speck or flaw, or French hard porcelain which has a perfectly white body covered with a water-white glaze, have an unsatisfactory effect. It is significant that the Chinese ideal of a beautiful material is not diamond but jade, which is a fibrous mineral, baffling and intriguing the eye by its microscopic complexity.

The Chinese compare the finest specimens to "mutton-fat." The expression "fatness" in relation to fine glazes is frequently encountered. There seems to be no reason why the same superlative description should not be earned in the enamelling industry. Modern wet process enamels too often look cold and muddy. A personal view is that clay suspension is one evil influence, and the excessive use of soda another.

One other aspect of enamelled or glazed objects may

Surface Properties of Vitreous Enamels

be mentioned here. By Lambert's law, light is diffusely re-radiated from a flat illuminated surface according to the equation.

$$I = I_0 \cos \theta \quad .. \quad .. \quad \text{(iv)}$$

where θ is the angle of the intensity measurement to the normal.

Since in a direction θ, unit area of the surface will exhibit a projected area equal to $\cos \theta$, the intrinsic illumination of the surface appears to be constant and independent of the angle of observation. A red-hot iron ball looks equally bright all over its surface. The sun looks like a bright yellow disc. The law is not always true. R. W. Wood has shown that it fails in the case of X-rays and fluorescence inside glass, but it is generally true for ordinary light. It has the important effect that round unglazed objects appear rather flat.

Calculation of the Distribution of Diffuse Reflection

The diffuse reflection from an enamelled or glazed object is obtained by virtue of the return of part of

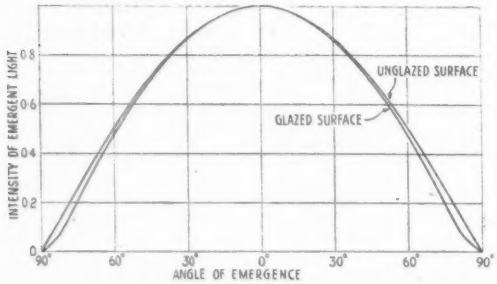


FIG. 4.—DISTRIBUTION OF DIFFUSED REFLECTION.

the light which has entered the glass surface. A basis has been found for calculating the distribution of diffuse reflection by considering that the opacifying particles in the enamel act as a uniform surface, radiating according to Lambert's law. By internal reflections and refractions one might expect a ray of light entering the enamel to have an equal chance of emerging in any direction, but the same should be true of a flat unglazed surface for which it is known that, probably through interference, the net effect is not an equal chance, but a chance proportional to the cosine of the angle to the normal. One assumes that light is approaching the surface from the enamel side distributed according to Lambert's law. On emergence the rays are refracted. All rays outside the critical angle are reflected back into the enamel. It is obvious that due to the refraction the light is relatively more intense near the normal and is spread out more thinly as the angle of emergence increases. The two types of distribution are compared in Fig. 4, in which the intensities in the normal direction have been equated. The difference between the two curves, although small, is probably sufficient for one to notice a reduction in intensity when looking at the edges of a glazed spherical object. Glazed objects, quite apart from the presence of high lights, should therefore appear "rounder" than unglazed objects, a fact which is borne out by experience. Stereoscopic vision relies on very small differences to create an impression of three dimensions. This quality of glazed bodies has the effect of making them stand out from their background, giving them an appearance of life and vitality.

The part played by smoothness in promoting brilliance has already been noted. When an enamel or porcelain surface is closely examined by the naked eye, using oblique illumination, it is seen to be remarkably uneven. Even when the surface has an over-all flatness it is usually indented with a multitude of shallow depressions, and sometimes by great numbers of irregular grooves and channels. These imperfections in varying degrees are shown by all types of ceramic surfaces from low temperature enamels to hard porcelain glazes. They seem to be more characteristic of the glaze composition than of the temperature or duration of firing. The appearance of some of the most admired porcelain surfaces is more like that of soft tanned leather than polished glass. It may be remembered that Mr. Gladstone, who was a collector of old china, once said that the surface of Chelsea porcelain was "like the flesh of a young baby."

The effect of these irregularities is obviously to reduce the gloss, when measured over a finite area, but the eye seems to appreciate a high intrinsic brilliance of the material even when the reflecting surface is not continuous. The effect on the smoothness of the glaze is not known. Sharp irregularities would be felt as roughnesses, but these are seldom encountered in enamels, except when dust has fallen on the surface during or immediately after firing. The sensation experienced when one handles a piece of enamel is a dragging force, compounded probably of a true frictional force characteristic of the material and a reaction force opposing the movement of the skin in following the contour of the surface. It is to be remembered that the surface of the enamel is never chemically clean, and the fingers are usually wet, acidic and oily. The general agreement of different observers with regard to their sensations of touch suggests that the material plays a predominating part.

Sense of Touch in Relation to Ceramics

The sense of touch in relation to ceramics should not be under-valued. One Chinese collector who when given a piece to examine first closes his eyes and judges the quality of the porcelain with his fingers. The surface may be "hard" and "cold," or it may feel "warm" and "silky." It is this quality of "warm silky smoothness" which is so much admired. The finest pieces seem to have a visual quality which promises the sensation which will be experienced by touch. It would be a mistake to think that the average housewife is unappreciative of these subtle differences.

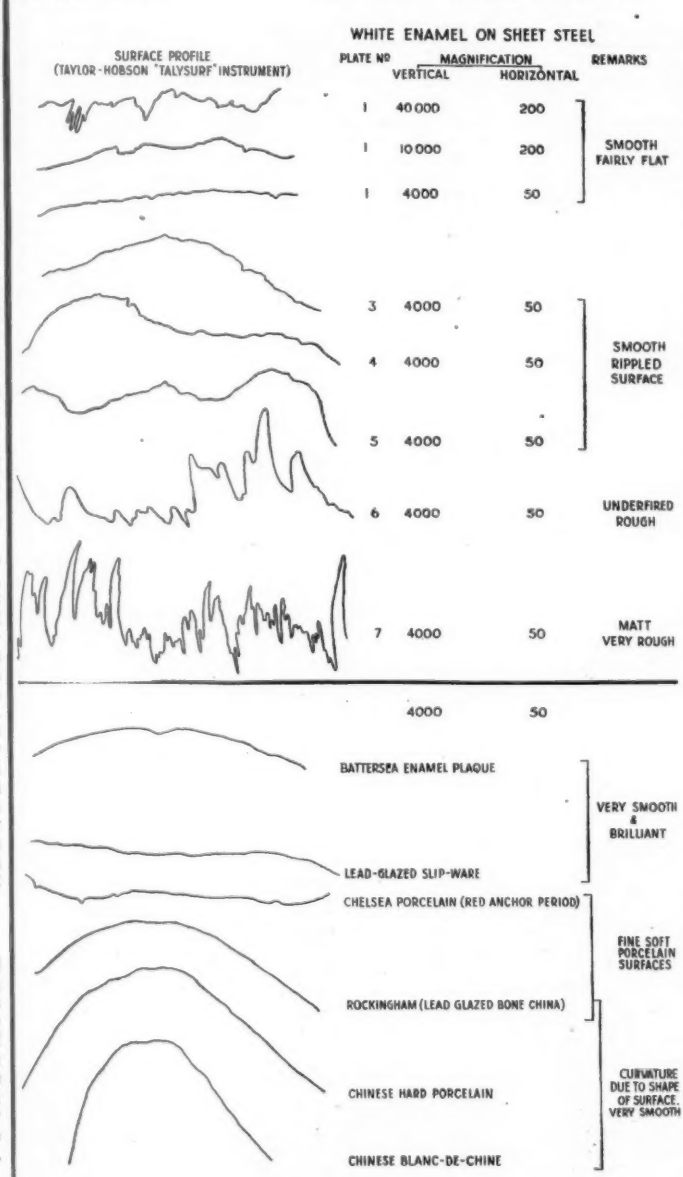


FIG. 5.—RECORDS OF THREE TYPICAL PORCELAIN SURFACES. (LINEAR REDUCTION.)

The different qualities of glassware, and particularly of window-glass, are very noticeable in cleaning. A tea-cup of bone-china is more pleasant to hold that one of stoneware. A hard porcelain pie-dish is easier to clean than glazed earthenware. It is possible that smoothness can actually be measured in terms of ease of cleaning, but the difficulties of specifying a test are considerable.[5]

Surface Finish

An idea of the smoothness can be obtained by measuring:—(*a*) The profile of the surface, and (*b*) the coefficient of friction, with request to a standard hard material such as polished steel. The nature of surface finish has received a great deal of attention in recent years.[6] A number of instruments have been developed on the principle of magnifying electrically the movement of a fine stylus over the surface. By the courtesy of Taylor, Taylor & Hobson, of Leicester, the Author has been enabled to record on one of their "Talysurf" instruments the surface finish of a series of white-enamelled sheet-steel plates, fired under varying conditions to give a range of brilliance and smoothness increasing by stages from a matt surface to a fully-fired enamel. Records of three typical porcelain surfaces have been included for comparison (Fig. 5). The same plates have also been tested for gloss and coefficient of friction. The Author is indebted to the Ferro Corporation, Wombourne, for the gloss measurements which were made on a standard Hunter reflectometer, the results being expressed as percentages of the gloss of a black glass standard.[7]

For the measurement of the coefficient of friction a simple device has been used in the Author's laboratories, which appears to give fairly consistent readings. It consists (Fig. 6) of a small steel block in which is embedded a $\frac{5}{16}$-in. dia. steel ball. Two arms of equal length extend outwards, and are bent down to bring the centre of gravity below the point of contact.

Surface Properties of Vitreous Enamels

The instrument is placed on the enamel surface and is set in rotation. By observing the rate of change of the speed of rotation a factor proportional to the coefficient of friction can be determined. Initially the motion will be opposed by two forces:—(*a*) Air resistance, which at low speeds is proportional to the angular velocity, and (*b*) frictional resistance, which is constant.

FIG. 6.—DEVICE FOR MEASURING THE COEFFICIENT OF FRICTION.

This gives

$$I\frac{d^2\theta}{dt^2} + C\frac{d\theta}{dt} + K = 0$$

giving a solution

$$\theta = \frac{I}{c}\left(w_0 + \frac{K}{c}\right)\left(1 - e^{\frac{-ct}{I}}\right) - \frac{K\,t}{c}$$

where w_0 is the initial angular velocity.

As the motion slows down, the air resistance becomes negligible, finally giving:—

$$\frac{dw}{dt} = \frac{-K}{I}$$

The value of K found depends upon the mass and dimensions of the instrument, but for a given instrument should vary only with the frictional quality of the surface. The speed of rotation is plotted against the time, and only the final straight portion of the curve used for determining the angular deceleration due to friction. In Table II the results are compared with the gloss measurements made on the same surfaces.

It will be seen that the frictional factor changes much more than the gloss in passing by stages from a matt to a fully-fired enamel. On the other hand, when the surface has reached a moderate degree of fusion, further firing continues to raise the gloss without much decrease in the frictional factor. The experiments (as far as they go) suggest that the gloss measurements agree with the appearance presented to the eye at high gloss values, but that the frictional factor gives a better index of roughness for semi-matt surfaces.

A study of enamel surfaces, using an instrument such as the "Talysurf" would, it is thought, open up a new field for investigation. In measurements of surface finish distinction is sometimes made between "waviness" and "roughness." In any case, two quantities seem to the Author important, the mean distance between crests and the mean amplitude of the waves. It would seem probable that a surface in which the waves have a mean slope θ, would oppose a reaction to the fingers equivalent to an additional frictional factor equal to $\sin^2\theta$. This would not be appreciable until the height of the waves was more than about one-tenth of the wavelength. It might be possible to correlate the surface profile of a surface with its frit composition, mill additions, firing, etc., and also to its ease of cleaning, smoothness and gloss. In this way firm guidance might be obtained towards providing the housewife with her ideal equipment.

CONCLUSION

In this Paper it has only been possible to indicate the scope of the problems that connect practical ease of cleaning and satisfactory appearance with the constitution and form of an enamel surface. Vitreous enamel is still unrivalled as a finish for certain pieces of domestic equipment. It can keep this position if one takes standards of reference from outside the industry and compare an enamel with a piece of porcelain rather than with another enamel. The Author has also tried to indicate the nature of the æsthetic qualities which are found in so many ceramic materials; there is no reason why they should not also be found in vitreous enamel.

He has already referred to the kindness of the Ferro Enamel Corporation and Taylor, Taylor & Hobson, in lending him the use of valuable instruments. He is also indebted to Mr. A. K. Williams and Mr. R. C. Andrews for much help and advice, and to the directors of Cannon Iron Foundries, Limited, for permission to prepare this Paper.

TABLE II.—*White Sheet-steel Enamels.*

No.	Reflectance.	Gloss.	Frictional Factor (Arbitrary Units).
1	79.6	57.0	35
2	76.6	56.5	53
3	76.0	55.0	51
4	76.0	52.0	48
5	74.8	48.5	59
6	71.5	44.5	300
7	69.2	36.8	356

5 See E. W. B. Dunning. "Domestic Gas Cookers—The Design of the Hotplate." Proceedings of the London and Southern Junior Gas Association, 1946.

6 R. E. Reason. "Surface Finish and Its Measurement." Journ. Inst. Production Engineers, October, 1944.
Taylor, Hobson Research Dept. "Report on the Measurement of Surface Finish by Stylus Methods"—1944.

7 Richard S. Hunter. "A Multipurpose Photoelectric Reflectometer." Nat. Bureau of Standards (U.S.A.). Research Paper R.P. 1345. Journal of Research, Nat. B. Stand. XXV. November, 1940

MODERN TRENDS OF VITREOUS ENAMELLING SHOP LAY-OUTS

The final Paper presented to the annual conference of the Institute of Vitreous Enamellers last November was by Mr. S. W. Vickery.

In the discussion which followed, MR. GRAY referred to a furnace in which nickel-chrome combustion tubes had been eliminated and replaced by a refractory muffle, and said he wondered whether that was due to difficulty in connection with the life of maintenance of the tubes, or whether it was found that efficiency could be obtained with a refractory muffle and a longer life obtained.

MR. VICKERY, in replying, said there were quite a lot of alloy tube installations. Users claimed that they got approximately 10 per cent. more efficiency. There was always one difficulty, he believed, and that was that there must be slow combustion, and this created problems which were not easily overcome. There had been difficulty with alloy tubes, and manufacture was not easy. Even to-day there were people who asked for an installation of alloy tubes, but he would say that the great majority of furnaces were refractory. Even the increased efficiency obtained was offset by the increased cost of the tubes in the first place, while maintenance was just as much a problem as with refractories, so perhaps it was a question of choice.

De-enamelling

Answering a question by MR. JENNINGS on de-enamelling, Mr. Vickery said I.C.I. had installed a caustic plant which they would demonstrate. In this installation they were using electricity to heat the tanks by immersion of the electrodes in the caustic and he should think it was quite economical. With steel short and the high cost of fabrication everyone should consider this addition to plant in view of the reject question.

MR. G. H. ABBOTT said that after de-enamelling the ware appeared to be softer and rather easily deformed.

MR. A. FORSHAW said he had had a plant working with caustic soda and found it did very good work in getting off old enamel. His firm had used it for a number of years with good results.

MR. WILLIAMSON said he had seen the I.C.I. plant quite recently, and he found that provision was made for the removal of sludge. There was a tray at the bottom of the tank, and after the process had been going on for a sufficient length of time to cause the caustic to become too viscous, the temperature was allowed to drop and the sludge precipitated out. The tray was then removed and filled up with new caustic to the required amount. As to possible danger of the process, from what he saw of it it was neither more dangerous nor more dirty than pickling.

The vote of thanks heartily accorded to the lecturer was proposed by Mr. W. Thomas (hon. secretary).

NEW CATALOGUES

Plant, Raw Materials and Supplies for Vitreous Enamelling. Stewart & Gray, Limited, Paisley Works, Swains Road, Tooting Junction, London, S.W.17, have just issued a particularly comprehensive catalogue covering practically everything required by the vitreous enameller. It is presented in loose-leaf form, the covers being both attractive and of solid construction. The advantage of a loose-leaflet catalogue resides in the possibility of keeping it up to date by replacing sheets, but in this case the sheets can only be identified by description, which could have been avoided either by pagination, or, better, the insertion of a reference number for each leaf. The make-up as received first deals with "Escol" enamels for cast iron and then for sheet, and in both cases useful technical data for their preparation are included. Then follow several sheets describing and illustrating the various loose tools used by enamellers, including a range of weighing machines.

The third section is devoted to fixed plant—grinding mills, pickling, shot-blast, compressors, spraying booths, magnetic separators, and sifting machines. Finally, there is a miscellaneous section, and therein are included perrets, electric process timer, portable grinders, a special type of lens, spraying equipment, enamelling processes, gloves and gauntlets. The catalogue is excellent, except that full use has not been made of the potentialities offered by the loose-leaf system.

Pneumatic Tools and Compressors. Armstrong Whitworth & Company (Pneumatic Tools), Limited, of Close Works, Gateshead-on-Tyne, and Air Pumps, Limited, of London, have issued a combined catalogue, the former concern being the selling agent for the latter. The catalogue, which, *grace à Dieu*, is not of the austerity type, is well illustrated and runs to 52 pages. Many of the tools detailed, such as sand rammers, dust guns, scaling and chipping hammers, are of distinct interest to foundrymen, whilst many of the wide range of drills and grinders are of the type used in the metal pattern shops. On page 18, *et seq.* there are printed some worthwhile hints on maintenance, but why should British workmen be made to wear American-type hats? The second section of the catalogue opens with a detailed description of the compressors of Air Pumps, Limited, and it is pleasing to see illustrated, on pages 36 and 37, the types of chisels available. This is a feature which has awaited detailing for a long time.

BIRLECOMEDY, 1946

Birlec, Limited, Tyburn Road, Erdington, Birmingham, 24, have again sent out a novel form of Christmas greeting. In a 16-page booklet, the writer recalls the trials and tribulations he experienced when "on the road" as a serviceman, whilst very subtly stressing the services his company now gives. To the reviewer, it was especially interesting, as he too has had a parallel experience, but in a still earlier period, when electrodes were square, and the tilting of melting furnaces was hand-operated.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patent)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

580,101 BRUSH DEVELOPMENT COMPANY. Apparatus for investigating surface roughness.

580,178 UNITED STATES PIPE & FOUNDRY COMPANY. Internal grinding of metal moulds and other tubular bodies.

580,245 BRITISH THOMSON-HOUSTON COMPANY. LIMITED. Forgeable alloys.

580,262 BRITISH PISTON RING COMPANY, LIMITED, TWIGGER, T. R., and JUDD, J.A. Manufacture of metal articles from powdered materials.

580,799 RADIATION, LIMITED, STEPHENS, S., DAVIDSON, W., and PICKARD, J. C. Solid fuel grates, stoves, ranges or the like.

581,394 FEDERATED FOUNDRIES, LIMITED, and CHAMBERLAIN, E. A. C. Open-close stoves.

581,454 UNITED STATES PIPE & FOUNDRY COMPANY. Method of reclaiming used metal moulds.

581,527 SPECIALLOID, LIMITED, and CANN, A. A. Light metal and light metal alloy pistons.

581,528 ABBEY, A. (Carborundum Company). Bonded silicon carbide refractory compositions.

581,542 WHEELER, M. A. Aluminium alloy.

581,549 MOND NICKEL COMPANY, LIMITED, and PFEIL, L. B. Anodes for the electrodeposition of nickel.

581,569 BRITISH IRON & STEEL CORPORATION, LIMITED, RILEY, H. L., and TAYLOR, J. Production of graphite.

581,571 SCHWARZ, E. H. Chrome-tungsten-cobalt-molybdenum steel.

581,572 SCHWARTZ. Acid-proof and heat resistant steel.

581,598 C.U.R.A. PATENTS, LIMITED, PIRANI, M., and HELLER, A. Refractory bricks.

581,604 LOWINGER, V. A., and CRESSWELL, R. A. Treatment of cast iron for the reception of tin coatings.

581,605 ARON, E., and POLLARD, E. Extrusion heads for injection moulding apparatus.

581,610 JACKSON, R. G., WILLSON, C. B. W., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Separation of minerals.

STEEL SUPPLIES AND MOTOR PRODUCTION

Presiding at the annual meeting of the Austin Motor Company, Limited, Mr. L. P. Lord, chairman, said that unless the Government changed its policy of steel distribution, their production would fall from an average of 2,033 to 1,800 vehicles a week during the first quarter of next year and an increase in prices was likely early in the New Year. It was hoped that they would receive a larger allocation of steel for the second quarter of 1947, so that they could look forward to a return to the planned production programme which rose to 3,000 a week by mid-1947.

IN PARLIAMENT

Restoration of Trade Practices

MR. ISAACS, Minister of Labour, in a written answer, stated that on the advice of the Joint Consultative Committee of the National Joint Advisory Council he had decided to appoint a day some time in December, 1947, as the end of the war period for the purposes of the Restoration of Pre-war Trade Practices Act, 1942. The necessary order would be made in due course. Employers would then be under an obligation to restore or permit the restoration of a trade practice not later than two months after the appointed day and to maintain or permit the continuance of the trade practice for a further 18 months. The only exceptions to this obligation provided by the Act were where the trade practice had been modified or waived by joint agreement or by arbitration. It was therefore essential that the two sides of any industry affected should consider this matter with a view to agreement on any point arising.

Steel Imports from Australia

MR. ERROLL, who asked the Minister of Supply what arrangements had been made for the importation of steel from Australia during the coming year; and how much could be expected from this source, was told that purchases would be made through the agency of the British Iron and Steel Corporation. It was expected that imports during the year would amount to about 200,000 tons.

When MR. BYERS asked the Minister of Labour whether it was intended that ironfounding should be scheduled for deferment on industrial grounds after January 1, 1947, in accordance with Section 8 of Cmd. 6831, MR. ISAACS replied: No, sir.

IMPERIAL SMELTING'S NEW PROJECTS

Production in the various plants of the corporation's metal and acid group had been maintained throughout the year at the highest level that plant capacity and availability of labour would allow, said Mr. J. R. Govett, chairman of the Imperial Smelting Corporation, Limited, presiding at the recent annual meeting. With the assistance of the Zinc Corporation, they had, during the year, applied to the New South Wales Department of Mines for authorities to prospect over an area comprising 12,420 acres contiguous to and lying to the south and south-west of the leases held by the New Broken Hill Consolidated. They had also under consideration extension of their activities in Australia for the production and handling of zinc concentrates and ancillary products, Mr. Govett added.

"THE STORY OF A WIRE ROPE," a film produced for Martin, Black & Company (Wire Ropes), Limited, of Coatbridge, describes the process of rope manufacture from the making of the raw material in the rolling mills to the final laboratory tests for durability and breaking strain. The film will be shown extensively to miners and their families.

PUBLICATION RECEIVED

Test-bars for 85 : 5 : 5 : 5 Alloy; Their Design, and Some Factors Affecting their Design, by Dr. G. H. Clamer. Published by the American Foundrymen's Association, 222, West Adams Street, Chicago, Ill., U.S.A.

This 36-page Report was given as the Fourth Annual A.F.A. Foundation Lecture by one of the most eminent past-presidents of the American Foundrymen's Association. The subject covered is one which is exercising the minds of metallurgists on both sides of the Atlantic. There seems to be a tacit understanding in the States that separately-cast test-pieces, if taken under properly controlled conditions, should suffice, while here there is a tendency to reconsider the advisability of using the metal in or attached to the actual castings. This Report details the work at the Battelle Memorial Institute by Mr. J. G. Kura, Mr. L. W. Eastwood and Dr. C. H. Lorig for establishing the design of a test-bar and the conditions for its realisation so as to ensure that even if the results are not indicative of the casting, they are of extreme value for the determination of casting quality. The Report firmly establishes the real utility of the production of separately-cast test-bars as a tool for the actual foundryman. Regular use by all foundrymen of a standardised system involving separately-cast test-bars over a period would probably stifle the engineer's cry for the attached variety. Dr. Clamer's Report certainly points the way.

MODERN FOUNDRY PRACTICE

A course of lectures on modern developments in foundry practice will be held at the Northampton Polytechnic, St. John Street, London, E.C.1, commencing on January 24. The lectures are to take place on each Friday evening at 7 p.m. A list of the lectures to be given, together with the names of the lecturers, is given below.

On January 24:—" The Testing of Moulding Sands," by F. H. Hoult; on January 31:—" Fuel Economy in the Foundry," by F. Hudson, F.I.M.

On February 7:—" The Melting and Casting of Brasses and Bronzes," by W. A. Baker, B.Sc.; on February 14:—" The Melting of Cast Iron in the Electric Furnace," by F. V. Lewis, M.A.; on February 21:—" Centrifugal Casting," by O. R. J. Lee, Ph.D., M.Sc.Tech.; on February 28:—" Mechanical Handling in the Foundry," by O. L. Pollack.

On March 7:—" Some Metallurgical Aspects of the Production of Magnesium Alloy Castings," by A. J. Murphy, M.Sc., F.I.M.; on March 14:—" High-duty and Special Cast Irons," by A. B. Everest, Ph.D., F.I.M.; on March 21:—" Some Developments in the Annealing of White Malleable Iron," by I. Jenkins, M.Sc.; on March 28:—" The Marketing of Castings," by R. B. Templeton.

The fee for the course is 12s. 6d., and admission is effected by personal enrolment at the Polytechnic any day from 10 a.m. to 7 p.m.

WELSH TINPLATE RECONSTRUCTION PLAN

Proposals directed towards the formation of a new company to undertake and supervise the modernisation of the Welsh tinplate industry are understood to have been carried a stage further. The assets to be transferred to, and operated by, the new company are reported to be as follow: The Port Talbot and Margam Works of Guest Keen & Baldwin's Iron & Steel Company, Limited; all or substantially all the tinplate works at present owned by Richard Thomas & Baldwins, Limited, with the exception of Ebbw Vale; all or substantially all the tinplate works at present owned by the Briton Ferry Steel Company, Limited; all or substantially all the tinplate works at present owned by Llanelly Associated Tinplate Companies, Limited; and the Newport steelworks of John Lysaght, Limited. In this case the assets will probably be acquired through the ownership of the equity capital of a subsidiary company specially formed for the purpose.

The carrying out of the modernisation programme which will involve the building of a new strip mill and cold-rolling plant, additional coke ovens and the rebuilding of blast furnaces, is subject to approval by the Steel Board and to arrangements for financing. The new company, it is expected, will be controlled by Richard Thomas & Baldwins, Limited. The whole plan is expected to cost between £36 and £37 million.

SUPPLEMENTARY LIST OF TOKEN IMPORTS

A fourth supplementary list of goods which can be imported into the United Kingdom under the token-import scheme has been arranged by the Board of Trade at the request of the overseas governments concerned. The individual overseas manufacturer's quota for 1946 for the goods in this list will be one-half of the quota of 20 per cent. for the calendar year, *i.e.*, 10 per cent. by value of his average annual pre-war trade in these goods with the United Kingdom. Import licence applications accompanied by token-shipment vouchers issued against 1946 token-import quotas will be accepted by the Import Licensing Department of the Board of Trade (189, Regent Street, London, W.1) up to February 28 next, both for goods on the present list and also for all previous lists.

The goods now added to the list include weighing apparatus, other than personal and baby scales, of less than 5 cwt. capacity and sold at a retail price not exceeding £50; beer barrels made of aluminium and aluminium alloys; aluminium and aluminium alloys in sheets, discs, wire, tubes, rods, angles, shapes and sections; aluminium kitchen utensils other than cooking utensils.

PRESIDENCY OF IRON & STEEL FEDERATION

In response to a unanimous request by the Council of the British Iron and Steel Federation, Mr. Ellis Hunter, president of the B.I.S.F., has agreed to stay in office for another year. Mr. Hunter is deputy chairman and managing director of Dorman, Long & Company, Limited.

NEWS IN BRIEF

THE FORMATION is announced of an electronics section of the Scientific Instrument Manufacturers' Association of Great Britain, Limited.

A NUMBER OF FURNACES of the Guest Keen & Baldwins Iron & Steel Company, Limited, have been converted to the burning of liquid fuel, and so far the results are reported to be encouraging.

FEARS THAT THE Walker-on-Tyne shipyard of the Shipbuilding Corporation, Limited, will be closed after present orders are completed were expressed at a meeting of Newcastle-upon-Tyne City Council.

BLAKE, BARCLAY & COMPANY, LIMITED, mechanical engineers and manufacturers of sugar-refining plant, of Greenock, have recently widened the scope of their activities to embrace the production of toys.

IT IS UNDERSTOOD that three of the four mills at the works of the Dafen Tinplate & Galvanising Company, Limited, Llanelly, which have been out of production since 1941, will be restarted in the New Year.

SIR MARK HODGSON, general secretary of the Boilermakers' Society, has stated that negotiations were in progress to secure guaranteed employment or wages and also a shorter working week in the industry.

THE SILVER JUBILEE of the Paterson-Hughes Engineering Company, Limited, Glasgow, was celebrated recently, when 300 employees dined as guests of the directors. Presentations were made to the nine oldest employees.

POLISH LABOUR is to be introduced at the Whitford Works, Briton Ferry, of Richard Thomas & Baldwins, Limited. It is understood that John Lysaght, Limited, Orb Iron Works, Newport, Mon, have also applied for Polish labour.

PIG-IRON IMPORTS into Eire in September were 377 tons, valued at £5,090, against 449 tons, valued at £4,435, in September, 1945. Exports of bog-iron ore in the same periods were 18,260 cwt., valued at £1,061, against 20,989 cwt. (£1,079).

BIRMID INDUSTRIES, LIMITED, state in their annual report that they are negotiating with the Government for the acquisition of wartime plant, etc., to meet increased demands. In due course, it is intended to apply for permission to issue more capital.

AMONG SEVEN Welsh steel sheet mills which will be opened early in the New Year—four at Neath and three at Llanelly—are the mills at the Melyn works, which have been idle since 1941. They are now being operated by the Neath Steel Sheet & Galvanising Company, Limited.

THE CLEVELAND BRIDGE & ENGINEERING COMPANY, LIMITED, are to spend some £50,000 on works improvement and the modernising of plant and equipment, including a large new fitting shop. This was announced by Mr. J. R. Dixon when he presided at the annual meeting of the company. He said there was also a heavy programme of deferred repairs throughout the works, necessitating an expenditure of about £35,000.

PERSONAL

MR. H. W. WELCH, who is secretary of Smith's Dock Company, Limited, has been elected to the board.

MR. R. STEWART has been appointed managing director of Lankester & Son, Limited, engineers, founders, etc., of Southampton.

MR. E. S. WADDINGTON, of Philips Industrial (Philips Lamps, Limited), has been elected a vice-president of the Society of Engineers.

SIR FINDLATER STEWART, Permanent Under-Secretary of State for India during 1930-40, has joined the board of the Finance Corporation for Industry, Limited.

MR. H. W. PINDER has resigned his positions with William Jessop & Sons, Limited, and J. J. Saville & Company, Limited, to commence business as a metallurgical technologist on his own account. His address is 6, Taptonville Road, Broomhill, Sheffield, 10.

MR. GEORGE SUMMERS retired on December 31 from his position of general manager of the Stirling Boiler Company, Limited; he will retain his seat on the board. MR. SIDNEY J. WHYBROW has been appointed to succeed Mr. Summers as general manager and has been elected to a seat on the board.

MR. E. BRUCE BALL, managing director of Glenfield & Kennedy, Limited, MR. C. D. H. MACARTNEY-FILGATE, managing director of Tubes, Limited, and MR. W. J. RUSTON, a director of J. Stone & Company, Limited, have been elected members of the governing council of the British Engineers' Association.

Wills

JOHNSON, W. H., a submarine expert, engineering works manager of Vickers-Armstrongs, Limited £14,058

HELM, F. S., of Bournemouth, late director of Francis Helm, Limited, ironfounders, etc., of Audenshaw, Lancs £22,409

MCMENEMEY, W. H., of Birkenhead, a former engineering manager and director of Cammell Laird & Company, Limited, and a former vice-president of the Institution of Naval Architects £31,956

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Pocklington—Supply and laying of about 1,800 yds. of 6-in. dia. cast-iron pipe sewers, for the Rural District Council. Mr. J. H. Haiste, consulting engineer, 4, Queen Square, Woodhouse Lane, Leeds, 2. (Fee £3 3s., returnable.)

Southend-on-Sea, February 3—Supply and installation of electrically-driven centrifugal sewage pump and Diesel engine-driven centrifugal sewage pump, together with all wiring, switchgear and cast-iron pipework, etc., for the Borough Council. The Borough Engineer and Surveyor, Southend-on-Sea. (Fee £2, returnable.)

STANTON-DALE
REFINED PIG IRON

Manufactured to guaranteed analyses in seven standard grades. Also obtainable to individual specification

THE 17-TON CASTING ILLUSTRATED IS ONE OF A SERIES MADE IN A STANTON FOUNDRY FROM STANTON DALE IRON

1. Core being lowered into mould
2. Pouring the metal
3. Finished casting in transit

The
STANTON IRONWORKS
COMPANY LIMITED
NEAR NOTTINGHAM

COMPANY RESULTS

(Figures for previous year in brackets.)

Metal Industries—Interim dividend of 3% (same).

Thomas Bolton & Sons—Interim dividend of 2½% (same).

Bluemel Bros.—Final dividend of 10% (7½%), making 12½% (10%).

Aeroplane & Motor Aluminium Castings—Interim dividend of 5% (same).

Claud Hamilton (Aberdeen)—Profit, £1,288; dividend of 3%; forward, £8,089.

Climax Rock Drill & Engineering Works—Interim dividend of 5% (same).

J. Samuel White & Company—Final dividend of 10%, making 15%, less tax (6½%, tax free).

Aberdare Cables—Interim dividend of 6%, which it is anticipated will be followed by a small final dividend (6%).

Cape Asbestos Company—Interim ordinary dividend of 2½% (same); interim dividend on the 5% participating shares of 7½% (same).

Moss Gear Company—Net profit for the year ended August 31, £33,051 (£39,952); final dividend of 12½% and bonus of 5%, making 25% (same); forward, £77,054 (£76,228).

Brett's Stamping Company—Net profit for the year ended July 31, after tax and depreciation, etc., £11,341 (£15,584); final dividend of 10% (15%), making 20% (25%); forward, £14,001 (£14,620).

Acton Bolt & Fine Threads—Trading loss to March 31, £4,174 (profit £37,318); net profit, after tax provision, depreciation, etc., £7,466 (£9,604); dividend of 5% (nil); forward, £19,271 (£17,649).

Jonas Woodhead & Sons—Profit for the year ended August 31, £40,932 (£71,214); estimated E.P.T. refund, £42,900 (nil); to general reserve, £30,000 (£20,000); dividend of 10% (same); forward, £22,651 (£19,219).

Wolverhampton Die Casting Company—Net profit to June 30, after depreciation and taxation, £14,135 (£2,456 after crediting £3,356 taxation reserves not required); final dividend of 7½%, making 12½% (same); forward, £32,962 (£23,998).

Bertrams—Net profit for the year ended September 30, £27,313 (£23,449); to reserve for improvements £20,000 (£7,500); general reserve, nil (£10,000); dividend of 10% on increased capital (10%), and victory bonus of 5% (nil); forward, £7,114 (£7,130).

Plessey Company—Profit for the year ended June 30, £320,547 (£348,802); to depreciation, £132,143 (£84,679); income-tax, £95,000 (£157,000); general reserve, £25,000 (£75,000); final dividend of 15%, making 30% (20%); forward, £50,013 (£31,307).

Thompson & Southwick—Net profit to August 31, before tax, £9,930 (£150, plus E.P.T. refund £1,479 and tax reserve not required, £800); to income tax and E.P.T., £4,377 (nil); deferred repairs, £2,700 (£800); dividend of 10% (7½%); forward, £5,160 (£3,395).

Marshall Sons & Company—Trading profit for the year ended September 30, £88,693 (£78,246); dividends, interest, etc., £11,948 (£11,824); to directors' remuneration, income-tax, less E.P.T. repayable, and depreciation, £43,776 (£34,800); net profit, £56,865 (£55,270); final dividend of 10% (8¼%), making 13¾% (12½%); to general reserve, £20,000 (same); forward, £82,524 (£83,471).

Birmingham Small Arms Company—Trading profit of the company and its subsidiaries for the year ended July 31, £595,246 (£1,299,909); E.P.T. recoverable, £450,000 (nil); interest on tax cerificates, £20,919 (£29,850); profit on sale of lease, £45,000 (nil); provision for war damage, not required, nil (£89,173); to depreciation, £283,480 (£204,150); special depreciation, nil (£200,000); debenture interest, £51,668 (£53,069); fees, £9,038 (£9,034); premium on redemption of debentures, £979 (£956); income-tax, £280,000 (£465,000); war damage, nil (£7,850); retained by subsidiaries, £91,903 (£68,067); deferred repairs, etc., £150,000 (same); to general reserve, £39,242 (£37,865); written off investments in subsidiaries, £100,000 (same); dividend of 7½% (same); forward, £186,538 (£214,965).

OBITUARY

MR. WILLIAM HENRY GATLEY, of Gatley & Company, electrical engineers, of Todmorden, died recently, aged 63.

MR. NORMAN HUGH DALE, a director of Bristowes Machinery, Limited, Edmonton, London, N.18, died on December 19.

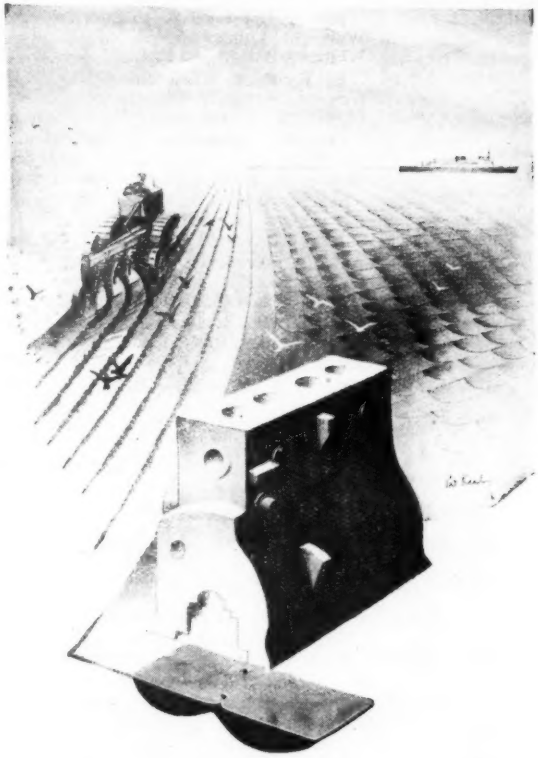
MR. ERNEST FRANK HEAVER, who died on December 19, was managing director of Frank Heaver, Limited, engineers' agents, of Bideford, Devon.

MR. ERNEST REGINALD JONES, for many years chairman of Jones & Attwood, Limited, heating and hydraulic engineers and ironfounders, of Stourbridge, has died at the age of 62.

MR. EDWARD TAYLOR, of S. T. Taylor & Sons (1937), Limited, boiler covering contractors and sheet-metal workers, of Scotswood, Newcastle-upon-Tyne, has died at the age of 89. He was chairman of the Tyne Metal Company, Limited, Hexham.

MR. JOHN BODEN, who in 1924 was appointed sales manager to Brooks & Doxey, Limited, engineers, ironfounders and textile machinists, of West Gorton, Manchester, and later appointed a director of the company, died recently. When the company became associated with Textile Machinery Makers, Limited, he became a member of the central sales staff. Mr. Boden was later appointed a director of Asa Lees & Company, Limited, Oldham. Latterly he acted as manager of co-ordination for the Textile Machinery Makers' group. He was 54 years of age.

WORKINGTON CYLINDER IRONS



High-duty irons of suitable compositions for cylinders, chemical use, wear resistance and other special needs are readily achieved by using Workington Hematite Irons or "UCO" Cylinder Irons in the mixture. Machine cast and free from sand and unwieldy pieces, of uniform composition throughout each cast, easily handled, quick melting, requiring much less coke and lime in the cupola than ordinary pig, they meet the requirements of modern foundry practice.

THE UNITED STEEL COMPANIES LTD

WORKINGTON IRON & STEEL COMPANY

WORKINGTON Telephone: Workington 206 Telegrams: "Mosbay," Workington CUMBERLAND

Branch of The United Steel Companies Limited

W. 76

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Lero Engineering Company, 61a, Humber Avenue, Coventry—£5,000.

H. Walker (Engineers), 16, Leeds Road, Bradford—£4,000. H. Walker.

Union Foundry (Little Hulton)—£2,000. J. Crankshaw, Cartref, Heaton, Bolton.

Onward Engineers, 178-180, Dock Street, Fleetwood, Lancs—£5,000. R. S. and G. C. Dugdall.

G. D. Perry Engineering Company—£4,000. G. D. Perry, Hedgemoor, Cliffords Merne, Newent, Glos.

Fire & Safety Engineers, 5, Waterloo Street, Bristol, 8—£2,000. J. C. Gough and S. Crompton.

Fletcher Bros. (Pressings)—£53,000. A. J. Corbett, 95, Leominster Road, Birmingham, 11, subscriber.

Aycliffe Castings, N.-E. Trading Estates, Aycliffe, near Darlington—£10,000. W. J., J. E., and J. Boyd.

Kestrel Engineering Company—£2,000. S. J. Cawdell, 14, Eversley Avenue, Wembley Park, subscriber.

Belsham Plating Works, 2, Belsham Street, Hackney, London, E.8—£2,000. T. J. Turnell, J. H. and A. Brandon.

Malvern Plating Company, 3, Edith Walk, Malvern—£3,000. H. W. Harris, G. A. Mills, and F. W. Silverthorne.

County Metal Works, Langton Street South, Preston—£2,000. T. W. Whipp, F. Gardner, and W. J. Fryer.

Hakon Skafte, 33, St. James's Street, London, S.W.1—Consulting engineers, etc. £1,000. R. S. Yates and G. L. F. Ball.

Chatburn & Chantry, 290, Penistone Road, Sheffield—Furnace engineers. £1,000. H. E. and M. H. Chantry.

J. Bell & Son, 40, Long Street, Thirsk—Mechanical and general engineers, etc. £3,000. D. and J. D. Bell and J. Matthews.

Contel, 3, Albemarle Street, London, W.1—Mechanical engineers, etc. £2,000. E. W. L. Cowan and N. H. Teakle.

Stamping & Press Works, National Bank Buildings, 24, Fenwick Street, Liverpool, 2—£1,000. K. M. Price and R. Daniels.

Martin Shapcott, Lower St. Edmunds Street, Weymouth—Marine engineers, founders, etc. £2,000. M. and A. E. M. Shapcott and J. Reid.

Garran Engineering Company, Mill Road, Caerphilly, Glam—£4,000. E. J. Grant, W. J. Gardner, C. H. Steadman, and J. A. Sibbons.

Basingstoke Coachbuilding & Engineering Company, 22, Basing Road, Basingstoke, Hants—£3,000. A. W. and K. Benbow, and A. L. Mansfield.

G. W. Every & Sons, 49, Thornhill Road, Barnsbury, London, N.1—Gear cutters, general engineers, etc. £5,000. J. H. and G. A. Every.

British Harvester & Engineering Company, 47-51, Whitehall, London, S.W.1—£5,000. H. D. and M. V. Whitelaw-Wilson and E. C. P. Whinfield.

R. F. Baker (West Bromwich), 371, High Street, West Bromwich—Constructional engineers, etc. £2,000. R. F. Baker and W. E. Sutton.

Central Engineering & Merchanting Company (London), 113, High Holborn, London, W.C.1—£1,000. R. A. Straub and T. W. Bodilly.

Sharpe Tone—Mechanical and general engineers, etc. £3,000. R. A. Sharpe, 2, Copley Dene, Kippington Road, Sevenoaks. P. and G. M. Tone.

M.E.L. Products, Lees Road, Hebden Bridge, Yorks—General and production engineers, etc. £1,000. W. Marshall and H. H. Kershaw.

St. Leonards Engineering Company, Royal Victoria Garage, Mews Road, East Ascent, St. Leonards-on-Sea—£3,000. A. J. Cooper and E. Roscoe.

Baxter & John Shaw, 27, East Parade, Leeds, 1—Mechanical, electrical, general and precision engineers, etc. £3,000. J. Shaw and A. Baxter.

Gray & Barr, 140, Morley Hill, Enfield, Middx—Manufacturers of electrical and mechanical apparatus, etc. £1,000. M. S., R. M. and M. R. Barker.

S. & C. Walmsley, Atlas Inge, Bolton—Constructional, general, mechanical, and electrical engineers, etc. £100,000. S. R. C. and C. R. Walmsley.

J. Antrobus & Company, 17, Birch Lane, Longsight, Manchester—Engineers, millwrights and machinists. £1,500. J. Antrobus and G. E. Vickers.

Deleopold Products, 34, Sherrards Park Road, Welwyn Garden City—Manufacturers of machinery, etc. £1,000. L. de Leopold and A. W. Metcalfe.

Amecho, 170, Lee High Road, London, S.E.13—Manufacturers of tools, engineering equipment, etc. £2,000. H. S. Head, S. B. Mace and F. G. Butler.

C. W. Chapman & Son, 53, Norton Road, Stockton-on-Tees—General engineers, etc. £8,000. E. M. M., W., and E. Chapman, W. Young, and T. L. Henson.

L. D. Harrison, Thryft House, Ringinglow Road, Sheffield—Manufacturers of steel and other metals, tools, etc. £5,000. L. D., K. D., and F. K. Harrison.

Wesley & Clark Engineering Company—£30,000. E. W. Clark, St. Winifreds, Swains Road, Budleigh Salterton, Devon; P. Day-Winter, A. Watts, and R. Orth.

Wincast Manufacturing Company, 65, Victoria Street, Windsor, Berks—Engineers, etc. £1,000. C. D. Wright, R. S. Thomas, H. R. Barton, and J. Carr.

Pressings (Sunderland), Jubilee Buildings, Newbottle Street, Houghton-le-Spring—Ironmasters, etc. £1,000. L. Cockburn, C. G. Maltas, J. P. Young, and T. F. Short.

EMPLOYMENT IN OCTOBER

Details of employment figures for October indicate that the withdrawal of women from work has practically ceased, as suggested by the returns of the previous two months. The number of men in the working population dropped by a further 46,000 to 14,556,000 and is now 106,000 fewer than before the war, and 500,000 fewer than at the peak war period. Altogether the working population is now 606,000 more than in mid-1939.

Unemployment between October 14 and November 11 showed little change. There was a total increase of 873, according to figures issued by the Ministry of Labour and National Service. There was a further decrease of 2,327 in Wales, where total unemployment is now 54,029, compared with nearly 70,000 at its highest point in February.

TRADE DISPUTES IN OCTOBER

In the metal, engineering and shipbuilding industries in October last, 133,000 working days were lost by 18,100 workers involved in 53 stoppages, compared with 134,000 working days, 18,800 workers and 48 stoppages during September, according to statistics in the "Ministry of Labour Gazette." The total number of working days lost in all industries during October was 285,000, against 188,000 in September.

During the first 10 months of this year 185,000 working days were lost by 16,100 workers in 93 stoppages, compared with 132,000 working days, 26,100 workers and 167 disputes during the same period of 1945. In the engineering industry 533,000 working days were lost by 98,600 workers in 158 disputes during the first 10 months of this year, against 297,000 working days, 69,600 workers and 209 disputes in the corresponding period a year ago.

COMBUSTION TUBES

"Zircotube" is the trade name given to a new type of zirconium refractory-base combustion tube, used in carbon and sulphur analyses, marketed by the Harry W. Dietert Company, 9330 Roselawn Avenue, Detroit, 4, Michigan, U.S.A. These new tubes incorporate design and materials carefully chosen and processed to give tubes which will withstand high temperatures and thermal shock, and also resist metal splashes. Three other desirable characteristics offered are, accuracy in size, gas tightness, and extra long life at high temperatures up to 1,530 deg. C. The "Zircotube" combustion tubes are available in a complete line of sizes, restricted and open ends.

WILLIAM JACKS & COMPANY LIMITED
WINCHESTER HOUSE, OLD BROAD ST., LONDON. E.C.2.
CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
PIG IRON
REGISTERED TRADE MARK
All grades FOUNDRY, HEMATITE SPECIALS, FERROSILICON, &c.
NON-FERROUS METALS
COPPER, TIN, LEAD, SPELTER, BRASS, GUNMETAL
WILLIAM JACKS & COMPANY LIMITED
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2
13 RUMFORD STREET, LIVERPOOL.

Raw Material Markets

IRON AND STEEL

Chiefly owing to the scarcity of man-power, home production of iron ore remains obstinately at a low level, but imports of foreign ore have been increased of late and a further slight expansion of the output of pig-iron is recorded. Nevertheless, the supply has not fully overtaken the demand. This is more insistent in the case of high-phosphorus iron, which is required for the production of light castings, but the requirements of other branches of the foundry trade are also on a growing scale and applications for bigger tonnages of hematite and low- and medium-phosphorus iron are in hand.

Prevailing conditions tend to accentuate the pressure for semi-finished products. Sheet mills and re-rolling plants have an abundance of work in hand, but they need to be constantly on the alert to acquire sufficient material to keep the rolls turning. Sheet bars and slabs are not so scarce as billets, for which there is a heavy demand from the mills engaged on light sections and also from the wire works. Defectives as well as primes command a ready market, and small tonnages of electrically melted steel are being used to produce export material.

There is still a lot of material in the stock banks which is urgently required for immediate home use, but deliveries are still delayed owing to the lack of trucks. The congestion, in fact, has not been sensibly reduced and is fast becoming one of the biggest headaches of the steelmakers. Demand for steel both at home and abroad is still soaring. Plate and sheet mills have fully six months' work in hand, and if rather earlier delivery dates can be indicated for other classes of rolled steel, such as joists, channels, sections, rails, etc., there are abundant outlets for these classes as rapidly as they can be produced.

NON-FERROUS METALS

The Control of Non-ferrous Metals (No. 26) (Copper, Lead and Zinc) Order, 1946, which came into force yesterday (Wednesday), increases the maximum prices of copper, lead, zinc and zinc products as follows:—Copper, by £19 per ton; lead, by £15; zinc, by £15; zinc sheets, by £15; and zinc oxide, by £12 15s. The price of high-conductivity electro copper is therefore increased from £98 to £117 per ton; of good soft pig-lead (Empire and domestic) from £55 to £70 per ton; and of zinc (G.O.B. domestic and "Prime Western") from £55 to £70 per ton. Prices for other forms of these metals are correspondingly adjusted. The price of zinc sheets is increased from £66 2s. 6d. to £81 2s. 6d. per ton, ex works, and for Red Seal zinc oxide from £56 to £68 15s. per ton, delivered, with a similar increase for the other forms of zinc oxide.

These increased prices reflect the recent sharp upward movements in metal prices which have taken place outside the United Kingdom and which in turn affect the purchase prices paid by the Ministry of Supply. Holders of outstanding licences granted on or before December 31, 1946, will only be covered at the new prices now in force. The new Order further releases hot-rolled copper wire rods from acquisition and disposal licensing.

A resumption of trading in futures in non-ferrous metals would, of course, be welcomed, but there is no indication that the Government has made up its mind on this matter and it may be some time before anything is done in this direction. The policy of bulk purchasing has been far from successful and possible alternatives are constantly discussed in metal market circles. An indication of Government intentions in the future is long overdue, but it seems as far away as ever.

Statistics compiled and published by the British Non-ferrous Metals Federation reveal the rising trend of copper consumption. Unfortunately, fears are felt that shortage of fuel is going to restrict consumers' activities in the coming months.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

DETERMINING THE MOISTURE CONTENT OF SANDS

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In your issue of November 14, 1946, is an article entitled "A Simple Rapid Method for Determining the Moisture Content of Sand," upon the subject matter of which I should like to venture a few comments.

The deflection on the millovoltmeter scale read as moisture content depends upon the current which flows between the plates. The magnitude of this current varies as the voltage and inversely as the resistivity of the medium between them. So pure water will tend to reduce the deflection and give "minus" errors, whereas contaminated water increases the deflection with "plus" errors.

If the resistivity of the water is reasonably constant, it may be possible to judge the moisture content from the current, within certain limits. Accuracy, and consequently the usefulness of the device, would appear to depend upon this requirement. Unless the importance of this point is appreciated, it may well be that the errors will be greater than the value to be measured.

Should one load of sand have been moistened with 10,000 ohm-cm. rain water in a country district, and another have received that which splashes off roofs in a town (probably less than 1,000 ohm.-cm.), the figures recorded will not be the moisture content of the sand, but the relative resistivity of two samples of water. Between these two extremes lie an unlimited number of variables.—Yours, etc.,

N. E. P. HARRIS.

"The Red House,"
Trysull, Wolverhampton.
December 30, 1946.